DOCTOR OF SCIENCES

Participative Geographical Information System (PGIS) to assist cities in addressing Food Security issues through Urban and Periurban Agriculture. The case of Bacolod City, Philippines

Denil, Barbara

Award date:
2008

Awarding institution:
University of Namur

FUNDP
Faculté des Sciences
Département de Géographie

Rue de Bruxelles, 61
B-5000 Namur
Tél. +32 (0)81 72.44.72
Fax +32 (0)81 72.45.03
E-mail
francoise.orban@fundp.ac.be
Site Web
http://www.fundp.ac.be/facultes/
sciences/departements/geographie/

Participative Geographical Information System (PGIS) to assist cities in addressing Food Security issues through Urban and Periurban Agriculture. The case of Bacolod City, Philippines.

Dissertation présentée
par Barbara Denil
en vue de l'obtention du grade
de Docteur en Sciences

Composition du Jury :

Françoise ORBAN (Promoteur)
Cesar VILLANUEVA
Pierre DEFOURNY
Eric DEPIEREUX
Sabine HENRY

Décembre 2008

Rempart de la Vierge, 13
B - 5000 Namur (Belgique)

Imprimé en Belgique
ISBN : 978-2-87037-620-1
Dépôt légal: D / 2008 / 1881 / 48

Elaboration d'un SIG participatif au service des aménageurs urbains dans le but de sélectionner des parcelles d'agriculture urbaine, pour améliorer la sécurité alimentaire des communautés pauvres locales. Le cas de Bacolod (Philippines)

par Barbara Denil

Résumé : Dans les villes du Sud, l'un des problèmes majeurs est la croissance démographique explosive, tandis que l'agriculture est essentiellement orientée vers l'exportation. Par conséquent, lorsque les villes du Sud connaissent à la fois faible croissance économique et forte croissance démographique, le marché local ne peut répondre à la demande en besoins alimentaires. Elles sont alors nourries par le Nord, par le biais de programmes de coopération. Afin d'accroître leur autonomie, elles sont à la recherche d'alternatives telles que l'agriculture urbaine et périurbaine. Actuellement, cette dernière est présentée dans la littérature comme une contribution à la sécurité alimentaire des communautés situées dans les villes à forte croissance démographique. Parmi les différents outils de développement, techniques, sociaux, économiques, qui peuvent être intégrés dans le processus de l'agriculture urbaine, la cartographie est indispensable aux aménageurs locaux. L'intégration des perspectives des communautés aux SIG traditionnels peut conduire vers des villes plus durables en étant à l'écoute des groupes cibles avec comme objectif de mieux répondre à leurs besoins.

En priorité, cette thèse contribue à répondre à la question centrale suivante: «Est-ce que l'agriculture urbaine et/où périurbaine peut mieux répondre aux besoins d'une communauté grâce à un SIG Participatif (SIGP) orienté vers l'aménagement du territoire?» Ou, en d'autres mots, «Que fait-on, ou que peut-on faire pour faciliter l'intégration des perspectives des communautés et de l'agriculture urbaine dans la planification urbaine?» La pauvreté urbaine est l'un des principaux thèmes abordés par cette recherche. La réflexion-clé initiale peut se formuler comme suit: «Est-il possible de contribuer à la sécurité alimentaire des communautés pauvres, tout en répondant aux objectifs de l'aménagement du territoire d'un gouvernement? L'agriculture urbaine peut-elle aider à répondre au défi d'une croissance urbaine rapide?».

Précisément, cette recherche vise à élaborer un outil SIG Participatif permettant l'intégration des perspectives des aménageurs et des communautés, outil qui peut être utilisé facilement et mis à jour par les utilisateurs eux-mêmes. Des données provenant de l'administration locale, des enquêtes sociale et économique, de la cartographie participative, de la télédétection, ainsi que de certaines entreprises privées locales sont intégrées pour produire un Plan d'aménagement participatif qui proposera différents scénarios pour un avenir durable.

Un quartier pauvre de Bacolod City (Philippines) constitue la zone pilote. Une réplication dans la ville de Cagayan de Oro (Philippines) est en outre considérée pour tester la stabilité de la méthodologie.

Participatory Geographical Information System (PGIS) to assist cities in addressing Food Security issue through Urban and Periurban Agriculture. The case of Bacolod City, Philippines.

by Barbara Denil

Abstract : In Southern cities, one of the major problems is explosive urban growth due to various factors while agriculture is essentially export-oriented. Therefore, when cities of the South are in low economic growth and with an endless population growth, their local market cannot meet their food supply demand. They become fed by northern economies, namely through cooperation programs. In order to increase their autonomy they are seeking for alternatives such as urban farming. Periurban farming and urban farming' are frequently proposed in the literature as an alternative method for helping communities located in cities with a high population growth. Mapping is a useful tool for local urban planners in the creation of sustainable cities. In addition to traditional GIS process, the integration of the perspective of local communities ' may lead to more sustainable cities by listening and learning from the population with the objective of better meeting their needs.

The primary aim of this study is to investigate a central question: "Can Urban Agriculture and Periurban Agriculture meet the needs of a Community through a Participative GIS (PGIS) oriented Urban Planning?", or in other words, "What is being done, or what should be done to facilitate the integration of the Community perspective and the Urban Agriculture into urban planning?" Urban poverty is one of the major issues addressed in this research. The key reflection can be formulated as: "Is it possible to contribute to the food security of the poor communities while meeting the Land Planning objectives of a government? Can Urban Agriculture challenge rapid urban growth?".

Precisely, this research aims to elaborate a PGIS tool, integrating cities and communities' perspectives, which can be used and easily updated by urban planners. Data from Local Government Units, social and economical surveys, community mapping, remote sensing, as well as from some local private companies are integrated to produce a Community-based Land Use Plan that will formulate various scenarios for a sustainable future. It first focuses on a case study in Bacolod City, Philippines. Replication with the aim of testing the stability of the methodology, was carried out in the city of Cagayan de Oro, Philippines.

Dissertation doctorale en Sciences Géographiques (Ph.D. thesis in Geography)
Date : 17 décembre 2008
Département de Géographie
Promoteur (Advisor): Prof. F. Orban

« The world moves into the future as a result of decisions, not as a result of plans. Plans are significant only insofar as they affect decisions…if planning is not part of decision making process, it is a bag of wins, a piece of paper, and worthless diagrams." (Boulding, 1974)

Acknowledgements

Un moment émouvant est le jour où le doctorant entreprend d'écrire ses remerciements. …La fin est proche. Cela permet de remercier toutes les personnes qui ont supporté nos diverses humeurs au cours des années de thèse.

Mes remerciements s'adressent tout particulièrement au Professeur Françoise Orban. Sans elle, sans ses précieux conseils et nos multiples discussions, ici ou là-bas, ce projet n'aurait pas abouti. Je pense qu'il nous tenait particulièrement à cœur à toutes les deux…

I am grateful to Cesar Villanueva for all the talks in the Philippines or in Belgium. His opinion and advices were very useful for opening my mind on the Filipino situation. Many 'salamat' for his warmful 'mabuhay' during all the trips in Bacolod.

Mes plus vifs remerciements vont aux membres du Jury qui ont lu et évalué ce manuscrit : le Professeur Sabine Henry, le Professeur Eric Depiereux et le Professeur Pierre Defourny.

Merci aussi à tous les étudiants que j'ai croisés pendant ces 7 années de thèse, je leur souhaite bon vent…

My dear Filipino friends from Bacolod City, Abeth, Riggs, Terai, John Paul and also all the members of ESSC,…, you know that you are the best team! You will always be in my heart.

Salamat also to all the families from the Barangay 7 for their help and their smiles. I hope having contributed to a better quotidian life for many years.

Flo, Nico, Steph et JP, merci de m'avoir accompagnée jusqu'au bout. Sans votre soutien quotidien, sans nos concours de grimaces et sans vos conseils techniques cette thèse ne serait qu'anecdote…

Malchou, toujours là, présente quoi qu'il arrive…merci.

Mes chers parents, merci de m'avoir permis d'y arriver et d'avoir supporté mon stress depuis si longtemps. Vous avez été présents pour écarter les doutes, soigner les blessures et partager les joies. Cette thèse est un peu la vôtre, aussi.

Caro, ma famille, mes proches je vous suis reconnaissante de votre soutien même au travers des kilomètres.

Et vous, mes trois amours, mon Loupy, mon Dragonou et ma Coquinette, merci d'être là. Au fil des années, au travers de ces moments plus ardus, mon amour pour vous n'a fait que grandir…

Je remercie également ceux dont le nom n'apparaît pas dans cette page et qui m'ont aidé d'une manière ou d'une autre. Ils se reconnaîtront.

« La Reconnaissance est la mémoire du cœur »
Hans Christian Andersen

Table of contents

List of acronyms

Aw: Awareness
C2C: City-to-City Cooperation
CBD.: Central Business District
CbGIS.: Community-based Geographical Information System
CbLUP.: Community-based Land Use Plan
CBO.: Community-Based Organisation
CM: Community Map
CPDO.: City planning and Development Office
DII.: Density of Interest Indicator
ESC: Environment Social Community
ESSC.: Environmental Social Science for Change
FAO : Food and Agriculture Organization
FGD : Focus Group Discussion
FUCID : Fondation Universitaire pour la Coopération Internationale et le Développement
FUNDP : Facultés Universitaires Notre-Dame de la Paix
GDP : Growth Domestic Product
GIS: Geographical Information System
HBE : Home-Based Employment
ID : Income-Density
LGU : Local Government Unit
MCDA: MultiCriteria Decision Analysis
MSI : Mean Shape Index
NGO : Non-Governmental Organisations
NSO : National Statistics Office
PCA : Principal Component Analysis
PGIS : Participatory Geographical Information System
PHP : Philippino Peso
PPGIS : Public Participation Geographical Information System
RUAF: Resources centre on UA and Food security
SBI: Survey-Based Indicator
SSI : Statistical Spatial Index
SWM : Solid Waste Management
UA : Urban Agriculture
UNCHS : United Nations Centre for Human Settlements
USLS : University of Saint La Salle

Chapter 1. Introduction

Here, the state of the art of the methodology used in this research is discussed. First, two participatory methods, participatory GIS and community mapping are addressed in relation to the participative methods used in this research. Second, MultiCriteria Decision Analysis is presented. Finally, this chapter provides an overview on Urban Agriculture (UA), which constitutes the context of application of the specific methods exposed before.

1.1. Participatory methods

The fundamental characteristic of this research is the use of methodologies that involve the participation of a number of partners, or stakeholders. Under ideal circumstances in participatory methods, all the stakeholders involved are included in each step of the process, from the beginning.

Many methods of participation are described in the literature, and more than 30 terms about participation have been described (PRETTY, 1998). However in this chapter, the focus will be on Participatory Geographical Information System (PGIS) and Community Mapping (CM). Both tools allow local communities and stakeholders to be involved from the beginning.

In many projects cited in the literature, people are consulted, but not included as active participant in the research process. This is called "simple consultation" or "passive participation", and is placed low in the ladder of participation (PRETTY, 1994; ARNSTEIN, 1969). This research, however, seeks for deeper involvement of stakeholders. By seeking interactive participation of all stakeholders it is hoped to empower them.

It has been argued that participatory processes provide new insights and new understanding. Pickles (1995) and Veregin (1995) discussed the difficulties of giving a social aspect to the implementation of a Geographical Information System (GIS), or any other technology. It is challenging to "socialize" a modern technology and not easy to estimate the role and limitation of the GIS expert in doing so.

Public participation is important in community planning, but has been practiced in ways that range from manipulation to full empowerment. This range may be seen as a ladder of increasing participation, as suggested by Arnstein (1969). On the lowest rung, citizens are sometimes provided with information. At the top rung, the public has a full voice in the final decision, usually through a community organization, and are totally empowered (CRAIG et al, 2002; CARVER, 2001).

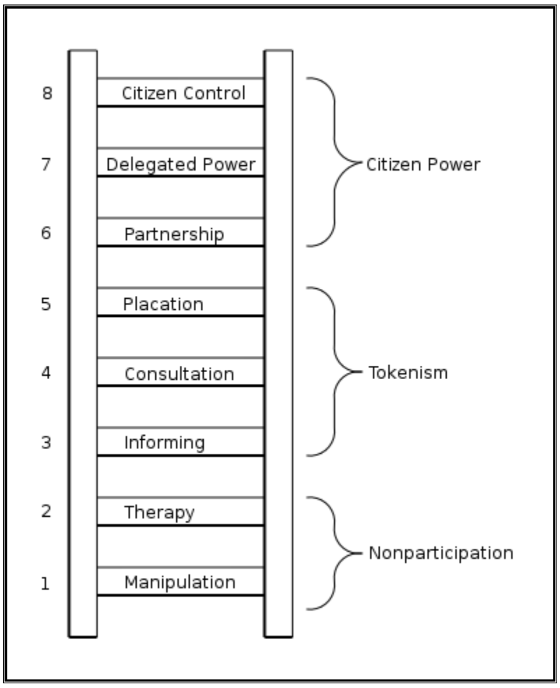

Figure 1.1: The ladder of citizen participation (ARNSTEIN, 1969)

On the bottom levels (levels 1 and 2), citizens are not included in the process of participation, but some decision-makers substitute those levels as genuine participation. On the third and fourth levels, people are allowed to hear and to have a voice but there is no automatic feedback from decision-makers to communities and finally the voice of the communities is not included in the final decision. On the last levels of participation, citizens have increasing access to decisions. If the communities climb the participation ladder, they will become more audible to the authorities, which will be supportive with a credible partner. This idea seems to be popular among some planners (JONES, 1990 *in* CRAIG et al, 2002).

Pretty (1994) proposes another typology of participation from active participation (self-mobilization) to passive participation.

Self- mobilization	People participate by taking initiatives independent of external institutions to change systems. Such self initiated mobilization and collective action may or may not challenge existing inequitable distributions of wealth and power.
Interactive (empowering) participation	People participate in joint analysis, which leads to action plans and the formation of new local groups or the strengthening of existing ones. It tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. These groups take control over local decisions, and so people have a stake in maintaining structures or practices.

Functional participation	People participate by forming groups to meet predetermined objectives related to the project, which can involve the development or promotion of externally initiated social organization. Such involvement does not tend to be at early stages of project cycles or planning, but rather after major decisions have been made. These institutions tend to be dependent on external initiators and facilitators, but may become self-dependent.
Participation for material incentives	People participate by providing resources, for example labor, in return for food, cash or other material incentives. Much *in-situ* research and bio-prospecting fall in this category, as rural people provide the resources but are not involved in the experimentation or the process of learning. It is very common to see this called participation, yet people have no stake in prolonging activities when the incentives end.
Participation by consultation	People participate by being consulted, and external agents listen to views. These external agents define both problems and solutions, and may modify these in the light of people's responses. Such a consultative process does not concede any share in decision-making and professionals are under no obligation to take on board people's views.
Participation in information giving	People participate by answering questions posed by extractive researchers and project managers using questionnaire surveys or similar approaches. People do not have the opportunity to influence proceedings, as the findings of the research or project design are neither shared nor checked for accuracy
Passive participation	People participate by being told what is going to happen or what has already happened. It is unilateral announcement by an administration or project management does not consider people’s responses. The information being shared belongs only to external professionals.

Table 1.1: Typology of participation (PRETTY, 1994, *adapted from* ADNAN et al, 1992)

The difference between both typologies of participation lies in the fact that with the second one, it is clear to see how people participate in development programs and projects. The first typology describes the transfer of political power from traditional power-holders having power over citizens, to citizens having the power to achieve their own requirements. Both typologies are complementary and both argue for an active participation of actors until the top rung of the ladder. However, with the definition of Pretty, it is easier to define the exact role of each participant and easier to establish the keys of success for any participative project.

1.1.1. Participatory GIS (PGIS)

One of the common methodologies used in geography is the Geographical Information System (GIS). This tool has many advantages but does not work with non-metric information such as maps drawn by communities (HARRIS and WEINER, 1998 *in* MACEACHREN, 2000) so-called "community maps" (refer to section 1.1.2 Community Mapping) and to work with specific social data (PICKLES, 1995 *in* OPENSHAW, 1997).

It has been argued that GIS is not ideal for decision-making because it works only for well-structured problems and it lacks abilities to support decision-making directly. Moreover, it does not contain tools to support group work (ARMSTRONG, 1993 *in* MACEACHREN, 2000). With this main criticism in mind, PGIS, a term used first by Harris et al. (1995), has been proposed as a way to make a link between GIS and social questions.

There are a number of different definitions of PGIS (Adapted from (RAMBALDI, CALLOSA-TARR, 2004; KYEM, 2005; CRAIG et al, 2002). Merging them, allows the building of a more comprehensive approach. PGIS results from a combination between Participatory Action, or Participatory Development methods, with Geographic Information Technologies (GIT). PGIS facilitates the representation of local people's spatial knowledge using two- or three-dimensional maps. PGIS practice is geared towards community empowerment through tailored, demand-driven and user-friendly applications of these geospatial technologies. It often relies on the combination of 'expert' skills with local knowledge. Unlike traditional GIS applications, PGIS places control on access and use of culturally sensitive spatial data in the hands of the communities who generated it. The other difference with GIS is that the beneficiaries of PGIS applications are the local communities and not the public officials as seen with GIS. The last difference is the nature of the issues addressed: PGIS aims at local empowerment, as opposed to official decision making for GIS.

A particular case of PGIS is the Community GIS or Community-based GIS (CbGIS), which is totally dedicated to benefitting a community. Such a system ideally should be 'by, for and of' a community. PGIS and specifically CbGIS provide relevant data and are capable of performing spatial analysis for participating communities (CASEY and PEDERSON *in* CRAIG et al, 2002; RAMASUBRAMANIAN, 1995). Specifically in CbGIS, people actively participate in the process of decision-making and the benefits of the CbGIS are oriented toward communities. Leitner et al. (2002) introduced this term with the idea of GIS in house and NGO-based GIS centers. However, this methodology must be "appropriated" by the target communities with a perspective of reaching self-dependency.

PGIS and CbGIS allow the inclusion and display of many types of spatial data. As it is possible to display not only physical or environmental data but also social data such as community maps, new correlations between layers of information can be revealed, which could provide new management decisions.

Throughout the literature, PGIS and therefore CbGIS are described as a powerful mediator between social and political power and intellectual practice in geography (CRAIG et al, 2002). Consequently, PGIS represents an opportunity to merge the differences between hard data, such as official information (statistics, governmental maps) and perceptual information such as social surveys. One of the means to involve local people more closely in local planning problems and decisions is mapping and consultation or discussion with them (CARVER, 2001). In addition, PGIS may help the promotion of bottom-up policy development. This approach could be a key for success since many projects that used a top-down non-participatory approach failed, including many projects of the World Bank (HUTCHINSON and TOLEDANO, 1993; STEWART et al, 2008).

An important criticism of PGIS as a tool is that it has rarely been implemented in developing countries. They represent more subjects of research papers than concrete actions. PGIS is commonly used in urban contexts for management or as a planning tool or for defining administrative boundaries (FORRESTER et al, 1999; ELWOOD, 2002 *in* CRAIG et al, 2002; CRAIG et al, 2002). It has been suggested that it is possible to find in scientific literature examples of constraints for GIS implementation, but nothing about social construction of PGIS in scientific literature (RAMASUBRAMANIAN, 1995). Moreover, many successful implementations of PGIS are presented in magazine, with little or no information on the difficulties encountered in the implementation, and cases of failures are rarely discussed. Therefore, there is a lack of rigorous information on the implementation of PGIS in developing countries, which needs to be addressed if the experiences of PGIS and CbGIS are to be documented for the scientific and planning community. This really makes this research original, pilot and challenging.

In all the studies using PGIS, it is assumed that the local social or political context has a strong influence on the outputs of the PGIS (GHOSE and ELWOOD, 2003). The context is not an easy factor to implement as it represents a complex set of relationships between government authorities, NGOs, scientists, individuals and the environment. Indeed the technical implementation of PGIS may be slowed down due to the obstacles of political factors (CRAIG et al, 2002).

Therefore, in order to be efficient, the partners involved in the project must be flexible due, among other things, to the unstable conditions of many developing countries. The political instability of the study area endangers the sustainability of many projects, as it may interrupt the process of decision-making. As an instance, scientists are able to build a GIS in general but are not aware of all the social implications of any projects implemented in a developing city. Consequently, they might not be able to build a PGIS, or aware of the added value in doing so. In addition, politicians are often perceived as corrupted by local communities. In this case, NGOs may play a role in identifying the adequate stakeholders and managing the relationships between communities and political leaders. Trust is a crucial element in PGIS (MATHER, 1997 *in* CARVER, 2001). The inclusion of external scientists or neutral experts may be useful in case of conflict between community and private partners. The scientists may give the same importance to each partner. It may also give a sort of legitimacy to data for the local planners.

The knowledge of local communities may bring a vision of the local process and practices and the difficulties encountered on a daily base. Moreover, if people are involved in the process, the results may be more legitimate to them. Conversely, communities alone may introduce bias in their judgment due to their lack of knowledge about the tool or the model.

Many studies,(a summary is provided in Craig et al (2002)), have illustrated the importance for NGOs and researchers to have easy and reliable access to data and GIS technology. Trust in outputs obtained through PGIS is sometimes litigious; there is often a bias in the accuracy of data that should be estimated and discussed before the implementation of the study.

There has been little research on partnerships between private partners (such as landowners or loans investors) in partnership with local communities. However, the inclusion of all the parties concerned by any project is one of the fundamental principles of democracy (OBERMEYER, 1998). In many developing countries, land has a multi- facetted significance. Privacy of land plot information is key-element for issues of ownership of property rights (CARVER, 2001 *in* MCCALL, 2003). Therefore, in order to be complete, a PGIS for agriculture management must require the participation of private owners of land. It has been argued that for urban planning applications the participation of all the stakeholders is crucial for the decision-making process (HEALEY, 1996).

In any case, the management of any large partnership constitutes a challenge, as each partner would have their own perception of the problem, leading to various forms of decisions. The geographer as a central coordinator of large partnership has to maintain a permanent dialogue with as many stakeholders as possible in order to ensure viable partnership (ORBAN and VILLANUEVA, 2001). In order to maintain good relationships between all partners, a 4 way-partnership has been proposed to be the most rewarding model.

The social status of the various participants is a significant variable in the success of PGIS. In most of the projects, local governments have a more powerful position than community organizations and they have established other modes of participation than communities. It is the case for a project of risk-assessment (vulnerability to hazards) in a developing country (KIENBERGER and STEINBRUCH, 2005). There, the intentional use of the maps for disaster preventive planning was not followed up and community maps were not used. The authors saw two major reasons for this:

* the objectives of the disaster risk assessment were addressing other issues and were not compatible with the thematic of the community maps;
* the funding agency, the process driving force, did not see the potential of the maps in their further plans of activities related to disaster risk management. The participation in this sense is located in the lower end of the "participation ladder".

Therefore, the process of decision-making may be blocked by this inadequate vision of participation. Often, people are invited to share their suggestions for development projects, but their advices are not considered in the final process.

It has been found that the participation of all concerned stakeholders has led to substantially more successful projects. For example, Gonzalez (2002) indicated that the help of local communities was fundamental in the project, which aimed at tracing the successful traditions in terraced agriculture in the Philippines. Indeed, the distinction of the exact boundaries of their territories by the local farmers was necessary to avoid misunderstanding between the stakeholders. Moreover, the participation of the government members added legitimacy to the project.

In such projects then decisions taken in consultation with all the concerned parties will be more sustainable. Moreover, if people concerned by the project are involved in the decision process they will be more prone to manage it with sustainability. Many European commission programmes (e.g.:EuropeAid, http://ec.europa.eu/europeaid/index_en.htm) already share this idea of global collaboration as well as the Department of International Development of the United Kingdom.

1.1.2. Community mapping

One way to include the perceptions or the needs and perspectives of the local communities in the PGIS is Community Mapping (CM). This community map may represent the participative side of the PGIS. The inclusion of the community viewpoint represents the ethical issue of PGIS (MAANTAY and ZIEGLER, 2006).

"Community mapping or mental mapping is an effective non-verbal way of finding out how people perceive their area and opposite to classic map" (WATES, 2000). According to Environmental Science for Social Change (ESSC, CBFMO, DENR, 1998), CM invite people to formulate their views and expectations in land planning. However mental maps are not geographically accurate. They are a way to stimulate debate about the different perceptions of the actors of the same area. Community maps, drawn on the ground or on plastic sheets using sticks or stones or any colored tools have the objective to express needs, views and perspective of the target communities and enable people to speak the same language as decision makers (MAANTAY and ZIEGLER, 2006). The term 'mental map' is also used in community mapping process.

Anybody who represents the community can draw an important element for them; each drawer is an actor. This is one of the crucial elements of the drawing process; the person who owns the sticks or the chalk is the 'boss'. Therefore, some studies have encountered a problem of cohesion between the communities facing the challenges of the community map object. The role of the neutral expert is to bring a social and political cohesion, needed in order to establish a successful community map (VOSS et al, 2004). In community map project, the communities have the major role, while others, like NGO representatives are only present for assistance.

Social and political local context are crucial elements for the citizen participation in Participatory GIS but also in community map (GHOSE and ELWOOD, 2003).

There are many types of community maps such as environmental maps, social maps and health maps. Most of the applications are oriented towards the management of ancestral domains or land conflict resolution (ABETO et al, 2004), such as the mapping of indigenous territories in Malaysia (LASIMBANG, 2004). One of the usual critics of the community mapping process present in literature since its origin up to now is the lack of urban experiences in developing countries (OPENSHAW, 1997).

Since the elaboration of this method (1930), community mapping is more oriented towards information exchange between community-government-researchers and NGO's. Unfortunately, few community maps have been used for an efficient project benefiting local people.

Often people are employed to draw features of their village to help to the implementation for a tool for which they do not have any knowledge. Implementors may declare that they worked in a participative way, but in reality no firm consultation with the local community has taken place. There is no feedback to the communities about the use of the maps and the map is used only as a 'poster' of the community. This was the case for the project in a Newfoundland fishing community who asked at the end of the project: 'We keep spending all of this time and money…but why haven't we seen any useful maps yet?' (CRAIG et al, 2002).

In the literature it is common to read that community maps are the easiest way to teach and cheapest way to collect data (DI GESSA, 2008). However, for greatest effectiveness, the NGO or any people who have to realize the map with the communities need to be trained by expensive experts. Local communities need to be oriented in their mapping and need to be guided in the thematic of the map; it is the role of the potentially expensive experts to outline a theme and to orientate the mapping process individually or by group.

This can be facilitated by the presence of a partnership such as government and/or NGO equipped with the same GIS software as the geographer or specialists. The efficiency and the robustness of the partnership are important for success of any community mapping projects. As in many studies, the success depends on the good communication between all the partners. The process of community mapping is not simply about inputting resources. It is the beginning of the people empowerment process (ESSC, CBFMO, DENR, 1998). Nevertheless, some researchers, such as Pickles (1995) did not see the maps as a way of people empowerment. Maybe he was not conscious that experts know that a social flap is inside their GIS (GOODCHILD, 1995 *in* OPENSHAW, 1997). Many International Land Coalition[1] network members develop strategic partnerships between government and civil society in order to make mapping outcomes binding. This has proven to be a viable strategy – although one that is difficult, delicate and time consuming. It increases the likelihood that the state will recognize land claims by rural poor and indigenous groups, including those documented through mapping (DI GESSA, 2008). In some instances, however, community mapping can highlight discords between local communities and the state agencies, as was the case for a project in Malaysia (DI GESSA, 2008).

The presence of a local NGO may be a key to success in a project where external 'foreign' experts are in charge of the community map process. However, feedback and discussions are compulsory with all the members of the communities in order to evaluate if the experts understood the visions of the communities. The NGO represents a good intermediate between people and specialists. The partnership can be reinforced by an official agreement between all the partners.

Community maps alone will not result in a total empowerment of people; an interactive digitized community map represents an opportunity to do so. The combined use of a PGIS is therefore important. The community map is then no longer a sketch map but should be used as an official scaled georeferenced map for discussion with city managers. Transforming social data into technical information gives an extra-value to the map (MALCZEWSKI, 1999). Unfortunately, due to the high cost of GIS software, projects rarely get to that stage.

The implementation of the community map may be difficult due to the fear of communities of the decision power system or their fear to be exploited. The community mapping process, nevertheless, is a good tool that scares fewer local communities than modern technologies such as GIS. New technologies in community mapping include the three-dimension map (relief models painted by the communities and embellished with important elements) in order to enlighten problem of ancestral domains, such as those encountered in the Philippines (RAMBALDI and CALLOSA-TARR, 2004). Such methods are also attractive for local communities as facilitating the communication.

Furthermore, community maps should be drawn several times in order to evaluate the efficiency of projects and to help to a better sustainable planning management (FORESTER et al, 1999).

---

[1] International Land Coalition: organization which promotes links between civil society and intergovernmental organizations to promote secure and equitable access to and control over land for poor women and men through advocacy, dialogue and capacity building.

1.2. MultiCriteria Decision Analysis (MCDA)

1.2.1. Generalities

The establishment of a model for a phenomenon or spatial process is quite difficult and needs to combine knowledge and competences from many domains and many techniques (SANDERS, 2001).

Since working in a developing country is complex due to the instability of the political context, the implementation of a system of multicriteria decision analysis (MCDA) may be combined with PGIS in order to improve the decision process. Since PGIS alone is not able to solve complex problems because it cannot evaluate the relative importance of each criterion[1]. PGIS assists MCDA and conversely, PGIS informs spatial decision-making process. Some analytical tools exist but their weakness lie in the decision[2]-support capability. For example, current software solutions do not:

(1) take into account solutions proposed by the decision-maker (current PGIS accept only quantitative criteria translating factual information);
(2) allow for personal preferences (only PGIS working with raster allow ratios for criteria);
(3) accept conflicting aspects (PGIS allow for constraints but not for conflicting data);
(4) allow assessment and comparison of feasible solutions (PGIS will identify solutions satisfying all criteria simultaneously but will not rank acceptable solutions, which is usually crucial for the decision maker).

A multicriteria decision support system is an interactive, computer-based system designed to support a user or group of users in achieving a higher effectiveness of decision-making while solving a semistructural spatial decision problem (KEEN and SCOTT-MORTON, 1978 in MALCZEWSKI, 1999). The definition of VINCKE (1989) reinforces the fact that MCDA could solve some problems with several points of view even contradictory. Another term that is often used is GIS-based Multicriteria Decision Making or Analysis, which is a 'collection of techniques for analyzing geographic events where the results of the analysis depend on the spatial arrangements of the events (MALCZEWSKI, 1999).

---

[1] Criterion : some basis for a decision that can be measured and evaluated. It is the evidence upon which a decision is based. Criteria can be of two kinds: factors and constraints.
(EASTMAN et al, 1993a; EASTMAN et al, 1993 b)

[2] Decision : choice between alternatives. The alternatives may represent different courses of action, different hypothesis about the character of a feature, different sets of features…

Fundamentally, the decision analysis divides a complex problem into small parts, analyzes them and combine them in a meaningful way. The multicriteria problem solving approach is based on a process that can be described by the following steps:

(1) identification of feasible or potential alternatives (variants or scenarios);
(2) construction of criteria to be taken into consideration;
(3) evaluation of the performance of each alternative with respect to every criterion;
(4) aggregation of these evaluations to obtain the solution that globally offers the best evaluations.

1.2.2. Challenges of MCDA

1.2.2.1. Criteria

One of the critical elements of MCDA is the choice of adequate elements to include in the MCDA systems, which are called the criteria. In the research, the integration of spatial information from the start is crucial.

Each criterion has to be comprehensive, measurable and rigorously scientific. These characteristics may be difficult to identify in some study case such as those implemented in developing country context. In order to analyze if the chosen criteria are relevant, a survey may be carried out among all the stakeholders. For instance, criteria could be non-measurable and could lead to conflict among partners of a project. As all the criteria are chosen in the beginning of the process, it seems that the presence of all partners at this stage is fundamental.

Moreover, the criteria have to represent the chosen variables but in a rigorous and comprehensive way. The manner of describing variables through criteria is critical. Many aspects have to be considered such as the numbers of criteria.

The choice of the number of criteria depends on the objectives of the researchers. If researchers want to represent reality as closely as possible, they must choose the maximum number of criteria. A reduction in the number may lead to simplified use but also to oversimplification. Researchers therefore must balance their choices. This may be discussed with all the partners in the case of a group decision-making process. If the objective of the MCDA is to reach a comprehensive decision, the maximization of the numbers of criteria is crucial, as all relevant aspects of the problem have to be analyzed (GRAILLOT and WAAUB, 2006).

Criteria have also to be weighted. These weights express the preference or the importance of each criterion for each stakeholder. Many procedures based on the judgment of the decision-makers have been proposed. This also indicates the need for the presence of each partner starting at the beginning of the process. It seems that if the objective is more a question of easy use and low cost, then ranking and rating methods seem to be adequate. Moreover, if the problem has to deal with multiple decision-makers, ranking and rating methods should be used. In the rating method, the weights are estimated based on a predetermined scale but with this method, the meaning of the scale might be difficult to justify. In GIS analysis, pairwise seems to be the most effective but some scientists argued that it is equivalent to the trade-off procedure in terms of effectiveness (LAI and HOPKINS, 1995 *in* MALCZEWSKI, 1999). With those methods, the individual weights are aggregated in order to give an average weight.

The chosen method depends on various elements, including the ease of use, the degree of accuracy that stakeholders want, the degree of understanding on the part of the decision maker.

As demonstrated by the case study in the Kathmandu valley exposed by Eastman et al (1995), Focus Group Discussion (F.G.D.), one of the participatory processes, may help for weighting attribution. Consensus about weight may arise from discussion between partners. A sensitivity analysis could be conducted in order to analyze the effect of changing the weight of an attribute in the ranking of alternative strategies and discusses the robustness of the results (GELDERMANN et al., 2006).

1.2.2.2. Stakeholders

The complexity of multicriteria analysis depends not only on the complexity of the problem to be analyzed but also on the numbers of stakeholders included into the process of decision-making. Each stakeholder has their own preferences that coordinators have to combine. This is what is called Group Decision Making and each interest of the stakeholders has to be integrated in a way that maximizes consensus and minimizes conflicts.

As all stakeholders might have different objectives, the solution is to prioritize objectives (EASTMAN, 1997) but the only way is to rank objectives and reach a prioritized solution, with a weighting approach and sometimes compromises. This management of conflicting objectives has commonly been approached by mathematical programming tools outside GIS or with difficulty in GIS analysis due to the importance of data sets.

The stakeholders may prefer to evaluate multi-criteria by way of the weighted linear combination, one of the most common multicriteria decision approaches with the concordance-discordance analysis (MALCZEWSKI, 1999; VOOGD, 1983 *in* EASTMAN, 1995; CARVER, 1991). This requires decision makers to express their preferences with respect to the importance of the criteria. A total score is obtained for each alternative by multiplying the weight assigned for each attribute by the scaled value given to the alternative on that attribute. After, the researcher sum the products over all attributes in order to obtain a suitability index. This method has the advantage to be easy-to-use but only in raster GIS.

As discussed earlier researcher has the role of prioritizing a chosen scenario. They have to interpret data, coming from the government or the communities in order to transform it in understandable information for others stakeholders and specifically for decision-makers. Moreover, their role is also to evaluate the good balance between hard information (e.g. official statistics, remote sensing data) and soft information such as community maps or surveys that express the preferences, opinions and judgments of communities for decision-makers.

Another critical point in decision-making as the choice of the relevant criteria is due to the inevitability to work with uncertainty about future events that might lead to a different outcome for a particular decision alternative, whatever the analyzed problem. For example, which cereal would a farmer like to implement. One way to deal with uncertainty in MCDA is a probabilistic analysis that is able to deal with uncertainty about the state of the problems and their environments and about the relationships between decision and consequences. The other way is a « fuzzy analysis ».

1.2.3. Applications context

Multi-criteria land allocation process has been tested successfully in the selection of the most adequate land for the implementation of an industry (EASTMAN et al, 1995) or as a tool to support sustainable management of groundwater resources in South Africa (PIETERSEN, 2006). MCDA seems to be an adequate tool in resource management (BEINAT and NIJKAMP, 1998). It is also used in habitat site development (JANKOWSKI et al., 1997) or health care resource allocation (JANKOWSKI and EWART, 1996). A more detailed list of operational MC-SDSS can be found in Malczewski (1999; Table 10.4, pg.: 336-337).

Nowadays, the working area of MCDA is more oriented towards operations research and management science but many examples are found in GIS implementation and it is now becoming a common methodology.

In the case of emergency management, methods for the selection of the most suitable strategy are not much discussed in literature.

Whatever the implementation, it seems that one of the most common criticisms is that MCDA can builds on subjective appraisals and assessments. However, these subjective assessments simultaneously provide a reflection of the diverse interests at stake and thus promote the transparency and the quality of the decision-making process. Another criticism is about the lack of discussion about implementation cases, such as in the emergency management.

1.3. Urban Agriculture (UA)

One of the major problems that developing countries have to face is the food insecurity. Firstly, the cities in those countries are facing a rate of urban growth that is increasingly hard to manage (1.8% urban growth rate) (COHEN, 2004). Indeed, 50% of the world population is urban (UNCHS, 2001). Secondly, food resources are badly distributed in the world. Currently, the North is fed by the South which is producing more food destined for consumption in the developed countries than food-producing cereals.

It is crucial to find solution to improve food security and one of the proposed answers is UA. This practice, born in Germany during World War II, may be defined as a way to produce food in cities or periurban areas by poor communities in order to, first be nourished and second, sell products on the local markets in order to be self-sufficient. With UA, people cultivate vegetables, fruits, or flowers along roads, close to their houses or in public spaces or private land. UA can also include raising small livestock, as well as including related activities such as the production and delivery of inputs, and the processing and marketing of products (RUAF, 2003; http://www.fao.org/ag/magazine/9901sp2.htm). This practice is commonly used in Africa or in South East Asia (RUAF, 2003).

UA plays an important role in enhancing food security since the costs of supplying and distributing food to urban areas is based on rural production and imports continue to increase, and do not satisfy the demand, especially of the poorer sectors of the population. UA is not only a way to insure against food insecurity but it is also a way to alleviate poverty or to socially incorporate disempowered people in the city life.

As many actors are involved in urban food security as summarized by Atkinson (1995) in the Figure 1.2., it is assumed that UA, source of food security will be maximized with the active participation of all the concerned actors. This condition should be fulfilled in order to take into account the needs of each of the stakeholders. This might bring a sustainable view in the process.

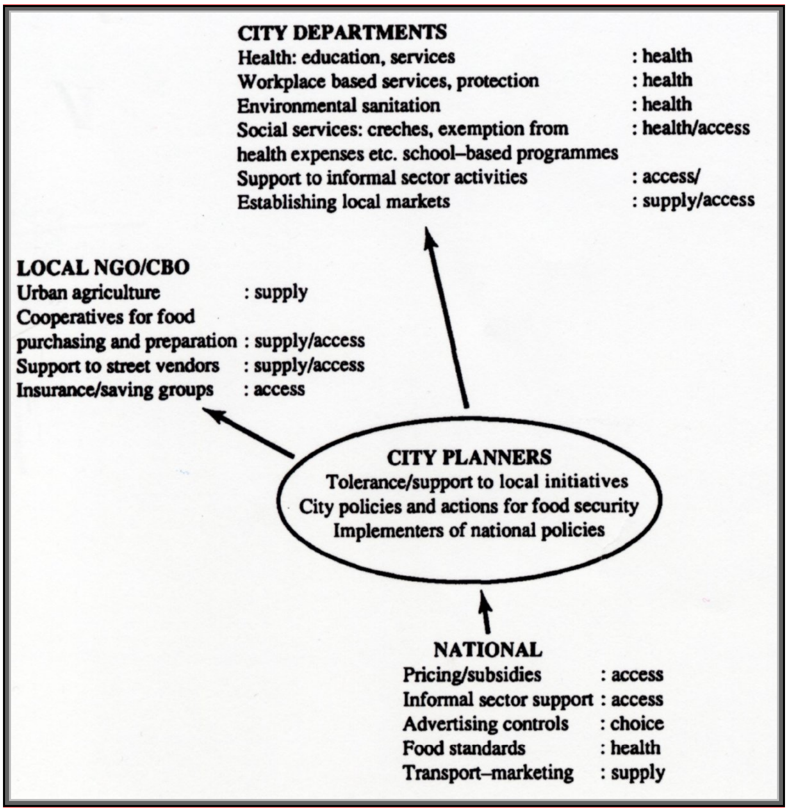

Figure 1.2: Approaches and actors in urban food security (ATKINSON, 1995)

An attempt of using people in the choice of preponderant factors for periurban agriculture implementation has been realized by researchers in Hanoi (THAPA and YUJI MURAYAMA, 2008; HOLMER et al, 2001). This study was implemented to select the more suitable land for agriculture through GIS and a multicriteria approach. The participative side of the study was brought by a consultation of people (local communities and agriculture experts) for the establishment of the lists of the most important factors. The study confirmed that UA might be implemented in a participative way. This study also demonstrated that GIS and MCA could be successfully combined in a procedure of land selection. This attests that participation is important and that the political leaders have to be involved in the project since the beginning of the research.

The results of projects from around the world argue in favor of UA even if some failures exist. UA in Latin America has been estimated to save a household 10 to 30% of its food costs, representing a saving of 5 to 20% of the total household income amongst the poorest families (CRUZ and MEDINA, 2003). Social benefits have also been demonstrated in the Philippines, where a community scheme for agriculture was started by two police officers whose primary concern was to reduce violence in the slum area. On the other hand, some projects failed because of lack of knowledge or lack of good management from the communities but also from the other partners such as government or NGOs. Nevertheless, governments can support UA initiatives through grants and legal titles to land and could enhance initiatives by facilitating temporary use of wasteland in the city. Since the beginning of the implementation of agriculture, farmers want to increase their production at lower costs through better crop varieties and production practices (HUTCHINSON and TOLEDANO, 1993). However, in order to be in agreement with farmers, researchers in agriculture practices have to work with the idea of minimizing the efforts of the farmers but maximizing production. These facts must be kept in mind in order to avoid failure, as was seen in some projects (SUMBERG and OKALI, 1989 *in* HUTCHINSON and TOLEDANO, 1993).

UA might also be seen as a sustainable way to produce food. One of the ways to be more sustainable with the UA is to use fertilizer or manure coming from an efficient waste management system (MIDMORE, 1995 *in* MIDMORE, 2003). SWM and UA have to work concomitantly. If people practice waste management at home with their own food rubbish, they may produce cheap fertilizer. With the waste of poor cities, which are estimated to be up to 60% organic, it is possible to produce compost (UNCHS, 2001). In many developing countries, if people practice waste sorting, they can sell the results of their sorting and earn some money to buy plants seeds or tools for gardening.

However, the use of true-composted urban wastes is scarce in developing countries and urban wastes are used to periurban horticulture (ALLISON and HARRIS, 1996 *in* MIDMORE and JANSEN, 2003).

The use of organic waste is also a means to 'prevent soil degradation or erosion by adding organic matter to the soil and closes the mineral nutrient cycle' (MIDMORE, 1995). Another important benefit of using organic waste is the solving of the waste disposal problem.

In cities, migrants, who are often the most marginalized, essentially come from rural areas. Therefore, they come with their knowledge and consciousness about rural practices

Chapter 2. Objectives and structure of the dissertation

The literature presented in the previous chapter proposed that food security is one of the main challenges facing developing countries and PGIS could be used to find a solution for this burden.

The conclusion of the previous chapter leads to the central research question:
Can a PGIS support the selection of plots most appropriate for UA in a perspective of food security?

The following sub-questions have to be answered:
Does quadpartite increase effective participation in PGIS?
Can PGIS help facilitate the participation of local communities?

The main objective of this research is to set up one methodology and apply it to two approaches: one maximizing the participative side and minimizing the technical side - Environment Survey Community approach (ESC) - and the second, which maximize the technical aspect and minimize the participative one –Statistical Spatial Index approach (SSI) -. This methodology aims at the selection of plots adequate for UA, source of food security in the context of a developing city.

Jointly, as specific objectives of the thesis, the results issued from both approaches are compared in terms of selected plots for UA. This helps to evaluate the impact of using a GIS-based participatory tool as one approach use a community-mapping process. Specifically, it may help potential users of the approaches to choose which is the most adequate regarding their context of application.

As the current research is mainly methodological, the thesis aims to develop a specific Participative Geographical Information System (PGIS): a Community-based PGIS. This CbGIS tool integrates data from different sources: local communities, local government unit, private partners (landowners or loans investors) and NGO's.

The general methodology finds its originality in a specific implementation of the partnership. In traditional methods, tripartite (FIDA, 2000) (communities, NGO's and government) are common but, in the current research, quadpartite partnership composed of local communities/NGO's, local government or cities, scientists or specialists and private could represent the key of the success of the tool on a implementation but also on a efficiency of the decision-making point of view.

As seen in the previous chapter (**Chapter 1**), the success of the PGIS depends on the complex relationships between all the partners from the data acquisition, until the decision making process and the presentation of the results. Moreover, the implication of the stakeholders from the beginning until the end of the elaboration of the methodology is clearly original.
Therefore, the dissertation is structured as follows:

- The choice of a robust quadpartite partnership which is suggested in the pilot study case choice is explained in **Chapter 3**;

- The principal characteristics of the pilot zone are provided in **Chapter 4**. The pilot zone meets the following criteria:
    - a developing city;
    - a context of extreme poverty requiring implementation of food security answer;
    - the motivation or knowledge for SWM source of manure for agriculture and/or UA in the targeted communities;
    - the strong relationships with targeted communities via local NGO's;
    - a City management office equipped with a GIS or open to share GIS capabilities and knowledge.

- The establishment and the comparison of the two approaches in order to give opportunities of choice between both, for future users, is explained in **Chapter 5**. Both methodologies have the same objective of selecting adequate plots for UA or SWM with the following criteria:
    - a soil suitability for UA
    - a correspondence to the needs, actual and future, mapped by the local communities themselves;
    - accessibility to farmers, machines, etc.;
    - existing or motivation for learning farming capabilities;
    - an economical viability.

- The main output, presented in **Chapter 6**, which is a Community-based Land Use Plan (CbLUP) for the pilot zone and contains:

    - a complete, accurate and updated Land Use classification for the pilot zone,
    - some development issues discussions on:
        - maps produced by the PGIS coming from the two different approaches,
        - answers to specific issues such as UA, SWM, food security,
        - estimation of the benefits for each partner.

- A replication in a larger zone in similar socio-economic conditions in order to test the robustness of the developed methodology is presented in **Chapter 7**. Some generalizations are made in order to simplify the approaches, such as in the variables or criteria selection process in the different steps of both approaches;

- The main findings coming from the establishment of the CbLUP and the replication are discussed in **Chapter 8**. All the implications coming from both approaches for all the stakeholders are also exposed. Conclusions and research perspectives end this chapter.

Chapter 3. Quadpartite partnership and its challenges

3.1. Quadpartite partnership

"What is needed is a better approach to help the poor, an approach that involves partnering with them to innovate and achieve sustainable win–win scenarios where the poor are actively engaged and, at the same time, other stakeholders providing products and services stand to gain too", argues Prahalad in his much-publicized 'Fortune at the Bottom of the Pyramid'. The Johannesburg Summit in 2002 advocated partnerships to achieve sustainable development.

According to Sharma (2007), tri-partite partnerships between government, donors and the private sectors have not yet produced good results but there is a promise of a better situation, such as in Delhi where projects are helping to solve urban problems with a partnership between the city's resident welfare associations and the government. As the resources delivered to people have not yet eradicated poverty, there is a need for innovative institutional mechanisms such as creating a particular partnership (SHARMA, 2007). As detailed in Chapter 1, partnerships composed of more than three partners are uncommon.

The specificity of the current research relies on a quadpartite dialogue partnership: public sector (government and cities), NGO-communities, scientists or specialists and the private sector. More specifically, all four partners are included in the process of data generation, sharing and validation, debate-discussion from the initial stages of the process, including the key decision-makers usually the landowners, who are generally included at the end of the process as part of the final stages. Quadpartite partnership represents a challenge in its implementation.

The Figure 3.1 briefly explains the role of each of the four partners and the nature of their relations:

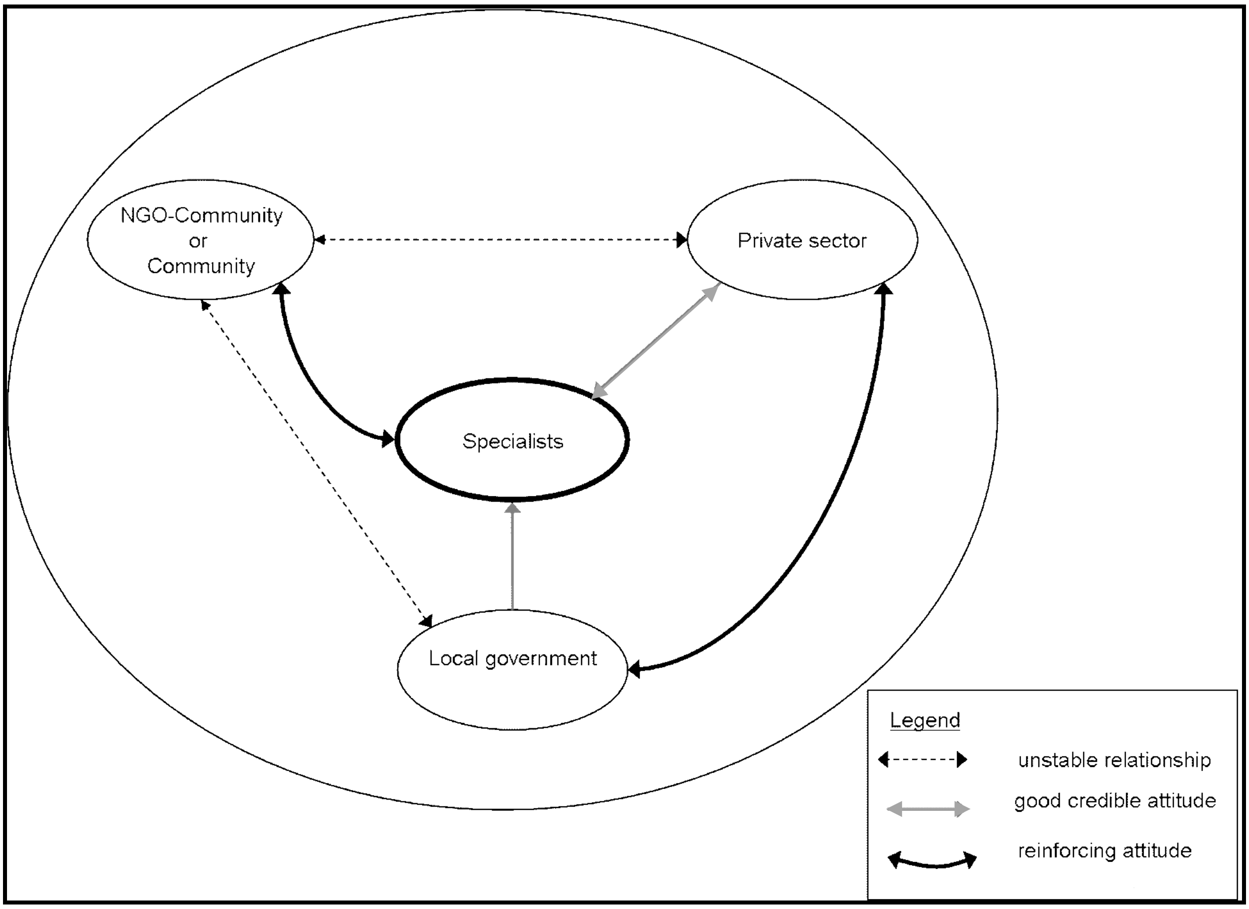

Figure 3.1: Quadpartite and relationships

3.2. Description of the four partners

3.2.1. Government and cities

3.2.1.1. Local government

Local governments represent a "dynamic" part of the partnership. The robustness of the project is and has to be supported by a partnership agreement at the start of the project. City officers provide data to the scientists' partners and vice versa.

In the current methodology, city government officers represent the last step in the decision-making process. Therefore, their awareness of the importance of being involved in the decision-making process from the beginning is crucial as they have the final power in the land planning implementations and should be emphasized in discussions.

The government structure in the Philippines is composed of units called Local Government Units (LGUs). One of their responsibilities is to create programs that take into account sustainable development. LGUs must work in relationship with the other partners and decision-makers. Therefore, communication and training is crucial at every level. It is also important to promote income generation and employment opportunities for low-income groups. Again, this is one of the roles of local government: support for informal activities such as UA. LGUs can provide support for land use planning, funding and technical assistance about the choice of the best vegetables to grow in UA (UNCHS, 2001).

"The transformation of a public agency into a "learning organization" is more likely to result in sustainable changes and benefits to "receiving" cities than mere technical information sharing" (UNCHS, 2001). Learning will be easily institutionalized if the "students" become the "teachers".

However, all these strategies need to be developed at the local level in order to gain further support at the international level. Or in other terms, these strategies have to be first developed on a small area in order to evaluate the challenges and second, the strategies should be replicated on a larger area.

City-to-city cooperation

For many centuries, neighboring cities have cooperated to resolve their problems, especially in terms of information-sharing during and after periods of warfare. However, it was in the last two decades of the twentieth century that cities became more active in international relations and that more links between the North and the South began to emerge.

"This process started at the Rio Earth Summit (1992), the Istanbul City Summit (1996) went much further in recognizing that cities and local authorities, as the level of governance closest to the people, are essential partners of national governments. And the international institutions in the processes of translating international agreements on economic, social and environmental issues into effective action on the ground" (UNHSP, 2002).

There are several reasons for this phenomenon of cooperation with cities: urbanization that affects countries worldwide and which creates population movements towards cities in developing countries, and globalization that gives cities a special status as a "hub" in the new economical system of decentralization. The will of governments to create a net of relationships for the future between all cities is also crucial in new city development. Moreover, the novel term 'decentralization' is also common in literature and means that decision-making powers shift closer to poor communities by devolving authority to local government.

In light of increasing urbanization and new economic trends, it has been proposed that inter-city cooperation might be of great benefit to cities in developing countries seeking to build more sustainable cities. This is commonly known as city-to-city cooperation (C2C). C2C is not only intended for cities in neighboring countries but also to cities in different continents, it is a form of decentralized co-operation. The policies of decentralized cooperation are based on partnerships between public authorities, NGOs, community-based organizations and private sector, mongst others.

Cooperation between cities represents a way to learn lessons from the experience of another city partner. The final goal is to improve "management capacity of cities for sustainable urbanization" (www.unhabitat.org, 10/09/02). However, before reaching this target, two major conditions must be fulfilled:
- the cities must know each other, must have similar interests;
- the cities must have the time to share experiences, solutions and results.

In the context of globalization, decentralization and democratization, cities have been recognized as "key-players". Cities have understood their roles into the reduction of poverty. They are able to act as the authorities for a sustainable development of local communities. The frequency C2C is considerably increasing from the initiative of cities leaders. However, they do not act alone; they require the encouragement and assistance of international associations, agencies, like in a partnership. When a city has a successful experience, the method is transferred to other cities in another context. As explained above, C2C is also used as the term "decentralized cooperation". The partnership idea is totally incorporated into this type of cooperation and is increasingly incorporated into the city-to-city cooperation (UNHSP, 2002).

This new approach development is a radical change in the mentality. At a local level, authorities take initiatives to elaborate policy processes within they declare to be potential partners.

The context of country's influences the possible implementation of the cooperation between cities. It means that, in developed countries, cities have legal power and some autonomy to build up cooperation. At the opposite side, developing cities have limited resources and no access to the decision level. Consequently, the emerging idea is to create city-to-city cooperation between cities in the "North" and in the "South". The first use their facilities with the profit of the latter. This has already been done since 1985 between a Nicaraguan town and six cities in Germany (UNHSP, 2002). A progress at the democracy level is in good process of implementation.

3.2.2. Non-Governmental Organizations/Communities or Communities

The term 'community development' was officially proposed at the British Colonial Office's Cambridge Conference on the Development of African Initiative in 1948. The first objective of the program was to prepare communities for independence by improving local government and developing their economies. They must pool their efforts to solve common problems democratically and scientifically on a community basis. Community Development was defined as a process which:

- "involves people on a community basis in the solution of their common problems;
- teaches and insists upon the use of democratic processes in the joint solution of community problems;
- activates and/or facilitates the transfer of technology to the people of a community for more effective solution of their problems" (EICHER and STAATZ, 1985).

Community Development human organizations and political process at its center. At the end of the development process each community should be able to raise standards of living with a social and political stability.

Current applications of CD involve Community-based GIS and active participation from all local communities is required. For a facilitated dialogue, the knowledge of NGOs is useful. The dialogue between communities and NGOs is usually strong as is the level of cooperation. For example when implementing a community development program that uses GIS, NGOs may provide the link between specialists and communities. The community may also be capable to make the link with specialists if they have certain autonomy in reflex.

In the context of UA and SWM, NGOs have many reasons to enter into these practices: social concerns for waste collectors, farmers, new technologies (composting or recycling), extending micro-credits, and concern for the poor environment to name but a few (SHAFIUL and MANSOOR, 2004).

As they are the direct beneficiaries of the research output, it is assumed that local communities are aware of many aspects of the project. If communities realize their existence could be improved by the project, data sharing can become more readily available. They may be willing to share information concerning their daily life and their current and future environment. As the current research is a participative project, communities will be consulted through participative activities, such as surveys, FGD or Community Mapping with a process of continuous feedback. In addition, they will be engaged in debates with stakeholders.

The edification, at the beginning of the project, of a partnership with local communities seems to be capital for sustainable development. A strong link between communities and all the other stakeholders is made generally by the local NGOs, which are in permanent contact with the pilot site's population.

"Empowering people means tapping into and releasing their talents, giving them the opportunity to become aware of their own value…It means …enabling them to make their unique contribution to the national community" (PHILIPPINE WORKING GROUP ON COMMUNITY FOREST MANAGEMENT, 1999).

3.2.3. Private sector

Private partners represent a specific side of the quadpartite partnership in the context of this thesis. In several projects private partners represent a strong constraint on a political or technical point of view.

Nevertheless, the active participation of the private sector is often encouraged in SWM projects. A strong link between the private and public sectors may improve the efficiency of the entire sector and create new opportunities for employment.

In this research, private stakeholders were divided into two classes: landowners and investors.

If the former do not accept to rent or lend their land, the project may be brought to a halt. The others stakeholders are therefore responsible for convincing them of the benefits of UA. For example in *Thailand and the Philippines, land sharing has also been implemented with respect to housing schemes. Land sharing is based on an agreement between the landowner (private or state) and the land occupants to develop the land according to their specific interest. Land sharing is a means to increase land tenure security and land value* (*Dowall, David, Clark Giles, 1997*)*…*" (DRESCHER (c), 2001). A series of discussions with landowners may sometimes result in an agreement being reached, as was the case in an Asia Urbs project in the Philippines (cf. 7.1 Context of replication).

Excluding the landowner's willingness to take part in the project means that the methodology will only consider environmental variables and thus attribute an agricultural value to the plot of land before giving the owner a "possibility of implementation" value. The main decision will remain on the political level to place pressure on the owner to accept an agreement on a temporary allotment gardening process.

In addition, UA is an important aspect of urban agribusiness from which the sector generates important income and employment opportunities. UA lacks access to efficient credit and investment support services. The agro-based industries play an important role in promoting UA, which can be enhanced by organized farmers' societies and favorable government environmental policies. The promotion of credit and investment in UA will require initiatives specific to the private sector.

In addition, in the case of rich industrialists they may not be willing to rent out their land if an industry could be erected on the plots in question.

Therefore, there is a real need for discussion and negotiation between all the stakeholders and private partners, which is sometimes difficult as landowners may live abroad.

Scientists and governments will share the same GIS software, with the aim of speaking the same "working language" and of providing help to local Filipino communities. Each partner will enlarge the GIS with specific data, based on their specifications.

3.2.4. Specialists

Usually specialists from diverse organizations (such as universities) are generally in charge of the data processing and the technical side of the methodology. The specific role of the researcher starts with the theoretical elaboration of the process. With the help of communities through NGOs, they collect data from the communities or from different governmental organizations. Moreover, specialists could be considered as central in the quadpartite partnership since they are in permanent contact with all other partners. They represent bridging task among the different stakeholders. They also represent a way to mix all the opinions of the different stakeholder's task, which could be considered as a political act. Moreover, they will be the ones transforming data from the communities into something rigorously scientific and at the same time applicable for the communities.

Scientists, have the advantage of working in an environment that encourages them to create and work. They may have all the necessary tools at their disposal and can share their ideas and results with the scientific community at seminars and world conferences. Unlike the others, scientists may remain neutral in their opinion of the process. They do not have to consider any political constraints.

Universities are usually integrated in projects essentially as research partners. In Canada, for example (WESCOTT, 2002), communities and universities share the same feeling that understanding and acting together on health problems may be done through the collaboration and integration of the diverse perspectives and resources represented in the project. The role of universities was to facilitate access to health data by communities through a GIS. In East Asia, the collaboration between regional educational and research institutes has acted in the prevention and management of marine pollution. In South Africa the private sector, communities and researchers acted for a more sustainable costal development. In Australia, the government is interested in partnership-based capacity building models; this is the case of a tripartite-partnership between researchers, communities and governments acting as a catalyst for marine matters (WESCOTT, 2002).

Collaborations between universities from developing and developed countries could also be considered as advantageous. The institution located in developing country could be in charge of the data collection through local NGO and communities. The university in developed country could be in charge of the data simulation. This requires permanent dialogue with both universities.

3.3. Relationships and their challenges

The major challenge in a quadpartite process lies on the power relationship within and among the key stakeholders.

In a developing country like the Philippines, the decision-making power often lies with the private landowners with the support of local government units on decisions regarding land usage. The private sector with their supporting legal advisers has always in mind the support of their own profit. The relationships between government and private owner are reinforced for this reason and not aligned with the interests of the communities since their objectives are often opposed. Fortunately, the private sector may believe in specialists as competent stakeholders.

NGOs and communities are often in conflict with the private sector and government due to the inadequacy of political decision making rules. This underlines the importance of the specialist for the implementation of adequate laws.

For a quadpartite process to increase the effective participation in the PGIS, it must assume an empowering relationship between the NGO, the community and the specialists including its academic base as community and empowerment-oriented. The relationship with specialists should be nuanced. Generally, foreign specialists are considered as credible partners by local government and other stakeholders. The presence of local specialists must also be envisaged but they have to be strong enough to convince the government and the private sectors partners.

Convincing the landowners to make his/her land available for UA with the support of the local government is often a delicate process. Unless this power relationship is considered their real participation may end up being mere tokenism. The implementation of the decision could be also facilitated since the government considers the specialist as a credible partner.

The quadpartite partnership assumes equity but in order to reach it, the actors must take into account a series of conditions, which could be considered as challenging:
- all the power relationships must be clearly established and understood by all the key-stakeholders;
- governments may be supportive and open to improve their land use management;
the private sector may have the willingness to rent their land in UA application or to support project with funds;
- the communities have to be well-organized;
- scientists and city partners need to have understood the social, economical, political, cultural and religious functioning of local communities as the understanding of a positive culture that encourages leadership and citizen participation, and that is related to the long-term development concerns of a community, is complex;
- self-evaluation and feedback processes are important;
- all stakeholders of any research project must have a realistic, commonly accepted vision that is based on the area's strengths and weaknesses, as well as on a common understanding of the area's potential;
- the specialists have to transform data with an applicable and rigorously scientific methodology for stakeholders;
- "a strong partnership should lead up to a participatory ethos in concerned organizations that can blend the self-interest of members with the broader interest of the communities" (AHMED and ALI, 2004).

If these preliminary conditions are not taken into consideration, any project with a specific partnership could see itself be blocked for a considerable amount of time.

The originality of the research may lead to ethical question. Indeed, unless the active participation of communities occurs but at the same time as the participation of government and private sector, the final decision lies in the hands of political leaders and private land owners. Such arguments have to be clearly debated with all the stakeholders and the benefits of the project must be discussed with them. According to Pedro Walpole (PHILIPPINE WORKING GROUP ON COMMUNITY FOREST

MANAGEMENT 1999), there is now a real need for communities' active participation in environmental management. Communities "have to be empowered, given tenure rights and access rights to resources" (PHILIPPINE WORKING GROUP ON COMMUNITY FOREST MANAGEMENT, 1999). In the case of forest destruction, and it may also be the case for many other environmental problems, projects can succeed only if they are vigorously promoted and if local communities are well supported. "It should be a major thrust of government policy". If communities are well supported, there is a need for good governance to achieve equitable and sustainable development (SORIAGA and WALPOLE, 2006).

Chapter 4. Case study

In this chapter, the context of the pilot case study is discussed. The pilot study has been selected according to the following criteria:
- Poverty situation;
- Food insecurity;
- Historical struggle for land;
- Existing partnerships between NGO and communities, between universities and government;
- Motivation of local communities and government for a new land management;
- City office equipped with GIS;
- Availability of data in city office;
- Small land area so facilitating the validation of results.

The pilot case study was carried out in a developing country, the Philippines[1], facing the situation of poverty and food insecurity. Moreover, the Philippines has faced struggle for land since many centuries due to various land reforms.

The City of Bacolod, the Barangay 7 and specifically one of the 4 puroks, Magnolia, of the Barangay 7 are motivated for a new land management through UA and SWM. This is facilitated by a partnership between local NGO, local and foreigner universities and government.

A cartographic overview of the area is provided in the Figure 4.1.

[1] In the Philippines, cities are divided into small political unities called barangays. Each barangay is divided into puroks, which are neighbourhood organizations. In our case, the City is called Bacolod and is composed of 61 barangays.

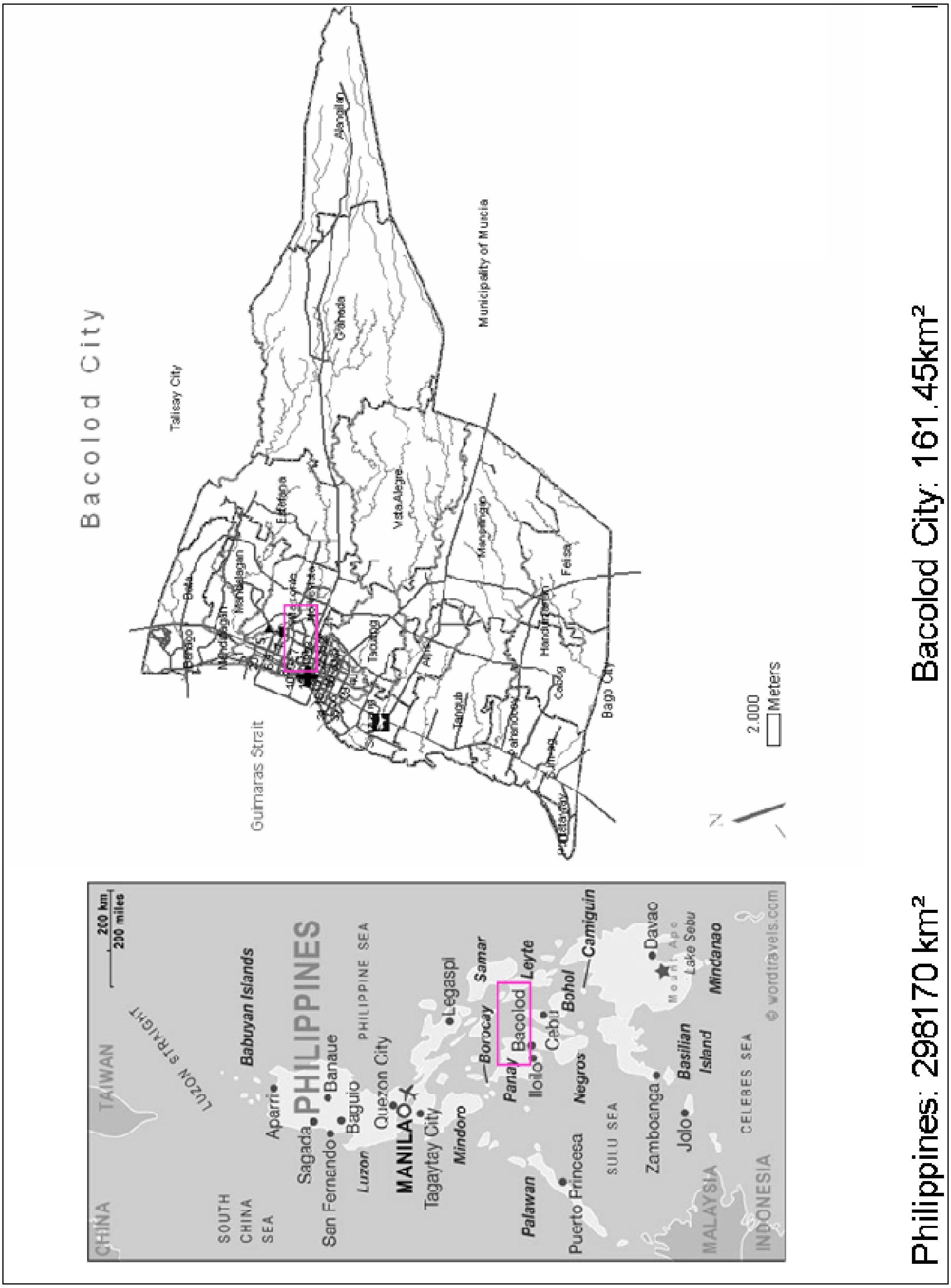

Figure 4.1: Context location

4.1. The Philippines

The Philippines is one of the world's many developing countries. In their mentalities, Filipinos are extremely motivated to bring about change in their lives. Moreover, the Philippines is a country rich in projects for development, such as fisheries or street children. This country has undergone several phases of economic and political destabilization, like the Asian crisis in 1997. Vis-à-vis these crises, the current President of the Philippines, Mrs Gloria Macapagal Arroyo, is highly motivated to change the situation.

Moreover, the Philippines are keen to implement UA. For example, in the capital, certain non-governmental organizations such as the Urban Food Foundation, and the University of the Philippines, are promoting this type of agriculture.

Nevertheless, implementing a development project in the Philippines can be highly challenging due to political instability of the country.

4.1.1. Geographical profile

The Philippines is a republic made up of 7170 islands (grouped into four major islands) in South-East Asia. This country of 300,000 km² occupies a strategic position to the South of China (966 km), south of Taiwan (240 km) and Malaysia, surrounded by the Philippine Sea on the east, the China Sea on the west and the Sulawesi Sea in the south (Figure 4.2). All these places represent connections with all the continents. The country is politically divided into 15 regions and 73 provinces. There are over 70 chartered cities, 1,500 municipalities and 41,000 barangays, which are the smallest political units in the country.

Figure 4.2: Location of the Philippines

The country occupies a surface area of 29.Mo hectares (CIA, 2005) mainly composed of coastal plains, interior valleys and plains. In terms of the latter, 17.17% is arable land, 16.28% irrigated land and 14.76% permanent cropland. In 1993, land use consisted of nearly 50% for forest and woodland and only 12% for permanent crops. As the following figure displays, the situation has changed considerably (Figure 4.3).

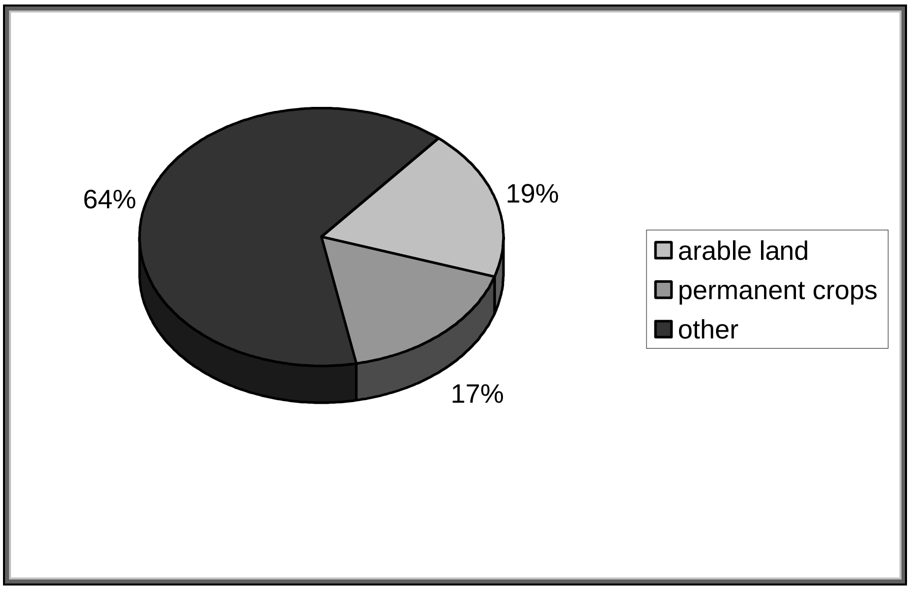

Figure 4.3: Land use in the Philippines in 2001 (CIA, 2005)

Another important fact that must be underlined is the unusual climate, related to the monsoon phenomenon; one southwest rainy monsoon (from May to October) and one northeast dry monsoon (from November to April). This climate constitutes a capital element for the development of the country. There is a higher occurrence of disease during the humid rainy season and during the dry season typhoons are frequent. Humans and crops are dependent on the hazardous climate.

4.1.2. Socio-economic profile

A growing population has always been a great problem for the Philippines. Ethnically, the population of the Philippines is a mix of all the country's colonizers. To understand the problematic situation of the Filipino population, the simplest indicator is the figure related to the total population showed in Figure 4.4 :

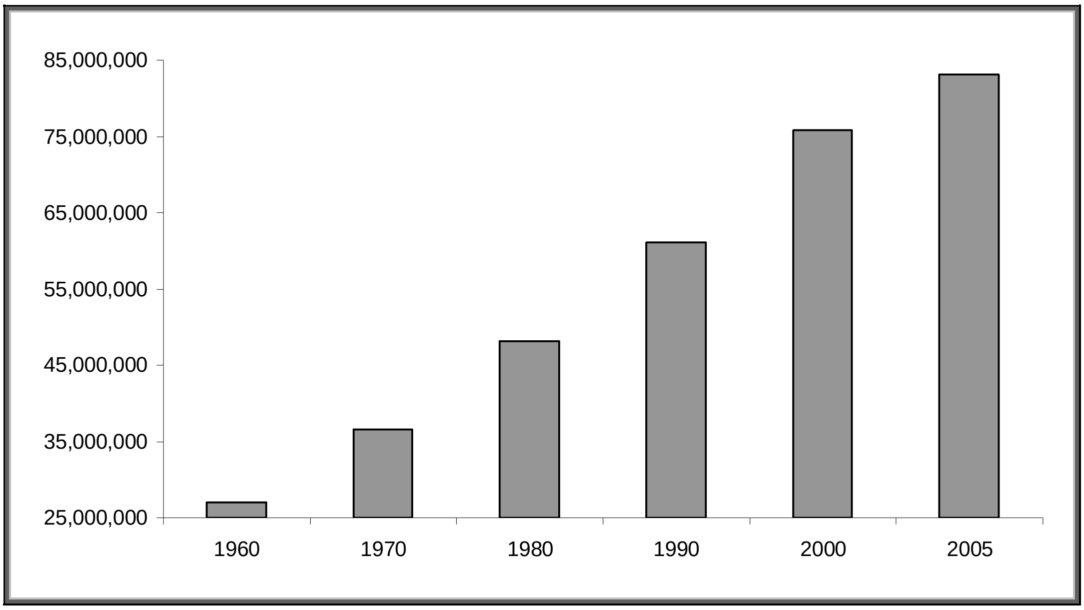

Figure 4.4: Population growth in the Philippines (http://perspective.usherbrooke.ca/)

As regards the population growth rate, it was very significant between 1985 and 2000: 2.2% by comparison with total Asia. This rapid population growth may be explained by a transition to low mortality (13 deaths per 1,000 births in 1960, and 4 deaths in 2005) and continued high fertility (3.2 births per woman).

In 2003, the annual population growth was 1.86%, compared with an average world population growth of 1.40%. The density in 1999 was 258 people per km²; with the same surface area, Italy had a density 196 people/km². The population of the Philippines numbered approximately 83 million people in 2005, with a land area of 300,000 km², which implies a density of 277 inhabitants per square kilometre. Correlated to this high density is the high number of households- 15661 in 2000; this is more than three times as much as in Belgium. On average, a Filipino household is composed of six people living in a one-room “house”. All these figures are strongly representative of a developing country.

A large number of Filipinos live in urban zones, 59% of the total population (44 million) in 2000 and this is predicted to increase to 74.3% in 2025 (UNCHS, 2001) (Figure 4.5). These are some of the highest percentages in East Asia; only the Republic of Korea with 86.2% (in 2000) of the population living in urban areas is higher. In comparison, 21.9% of the Thai population live in urban areas (in 2000). In the Philippines, urban population growth has been high. It is predicted to remain the same until the ‘2015-2025’ period when the rate will decline, while always maintaining a value of at least 2%.

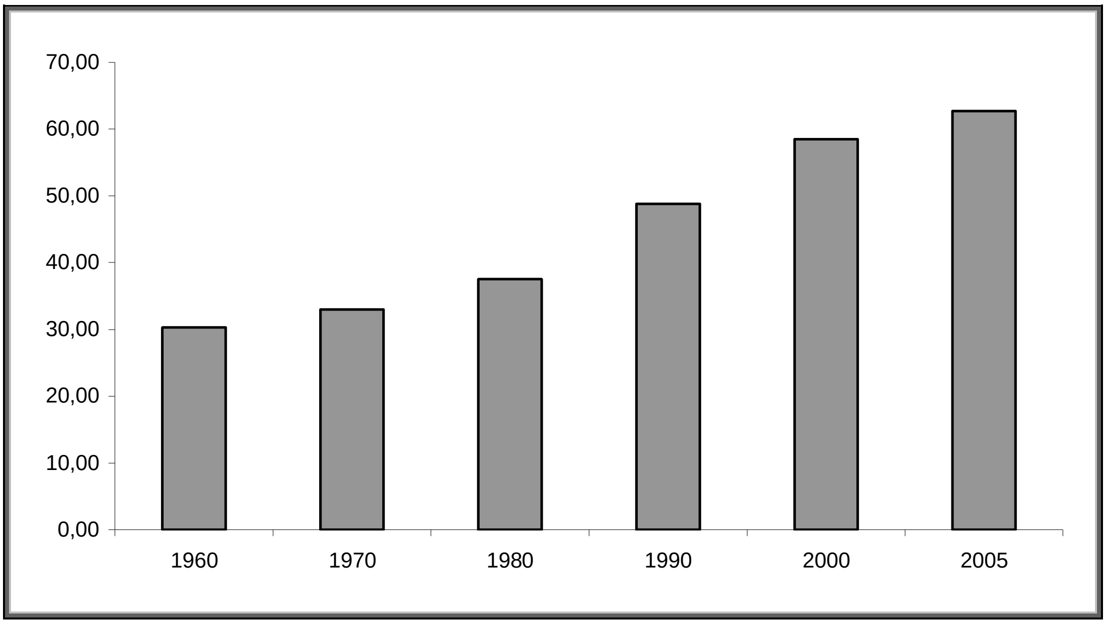

Figure 4.5: Urban population growth (in % of the total population) in the Philippines (PNUD, 2005)

Urban growth is five times higher than rural growth. However, in rural areas the situation is worsening at least for two-thirds of the country's poor. Statistics estimate that half of the Filipino population lives in rural areas, while agricultural land is owned by 18% of the population.

With this rapid urbanization, in the same conditions as today, 15 million more people will live in cities in 2010; this is equivalent to adding a metropolis the size of Metro Manila with 10.9 million inhabitants UNCHS, 2002; WORLD BANK, 2000). However, at the same time, the growth of secondary towns will also be very significant, but with dramatic consequences as they will not have not enough infrastructure to welcome the expanding population.

The urbanization phenomenon is particularly tangible in Manila where a mega-city has developed. In consequences urban slums and squatter settlements are widespread. In urban areas it has been estimated that there are over 10 million slum-dwellers and squatters throughout the country, but for UNCHS, 20 million people were living in urban slums with any adequate living structure (44% of the all urban population) (UNCHS, 2001). Twenty-six percent of 1.6 million people living in Manila are squatters in Metro Manila. One of the major problems of this rapid urbanization in the Philippines is the proliferation of street children. In 1990 there were estimated to be 60,000 street children in Manila and 25,000 in other Philippines cities.

The best solution to the problem of housing is security of tenure, but in the Philippines, 90% of the urban poor lack security of tenure and due to rising land prices the situation is not very improving. The rules of land reform propose different solutions for security of tenure but propositions do not support poor people and are not in line with Filipino mentality.

To resolve the housing dilemma, answers must be provided to problems of economic justice, social justice and urban reform. However, optimism is possible because, through the intervention of the different governments in South-East Asia, the living conditions of squatters can be ameliorated. For the time being, the Philippines ranks 9th out of 16 Asian countries in terms of the government's effectiveness (Figure 4.7) but with better management this weakness can be improved.

Currently, the country is facing a net migration rate of -1.47 migrants per 1,000 individuals (CIA, 2008). Emigration is present due to, among other factors, the lack of job opportunities and attraction of the USA for example. Emigration from rural to urban zones is also present in the country and migrants look for adequate housing and employment. Farmers represent the majority of migrants. In some cities, 60% of the population come from rural zones. Nevertheless, some people from rural zones migrate to other rural zones or small cities than Manila (QUISUMBING A. and MCNIVEN S., 2005).

Directly related to the worsening situation, data from 2000 revealed that, 15.5% of the population were living on only $1 per day, which is a substantial figure if compared to 21.1% for the entire world. In addition, in 1997, 36.8% of population lived below the poverty line (50.7% of the rural population and 21.5% of the urban population) (WORLD BANK, 1999).

Nevertheless, a report from the World Bank indicates that the Philippines have made significant progress in reducing poverty, from 34% in 1991 to 25% in 1997. However, after this relatively buoyant period, poverty reduction stagnated (+- 26% in 2000). Despite these advances, poverty is widespread in the country. This poverty is clearly described in the Figure 4.6: a small fraction of the population, the richest, owns 1/3 of the revenue, while the same fraction of the poorest population has only 2% of the revenue (PNUD, 2005).

The World Bank classified the Philippines as a lower-middle income economy like China, Iraq and the Russian Federation. This classification is a function of Gross National Income in 2001 per capita. The value is between $746 and $2975 for this class. Growth profiles indicate that the Philippines are progressively on their way to attaining the development levels of the newly industrialized countries of East Asia. Even if some factors could destabilize the country like the El Nino weather phenomenon or the Asian economic crisis in 1997 which has provoked a devaluation of the PHP and spiraling oil prices

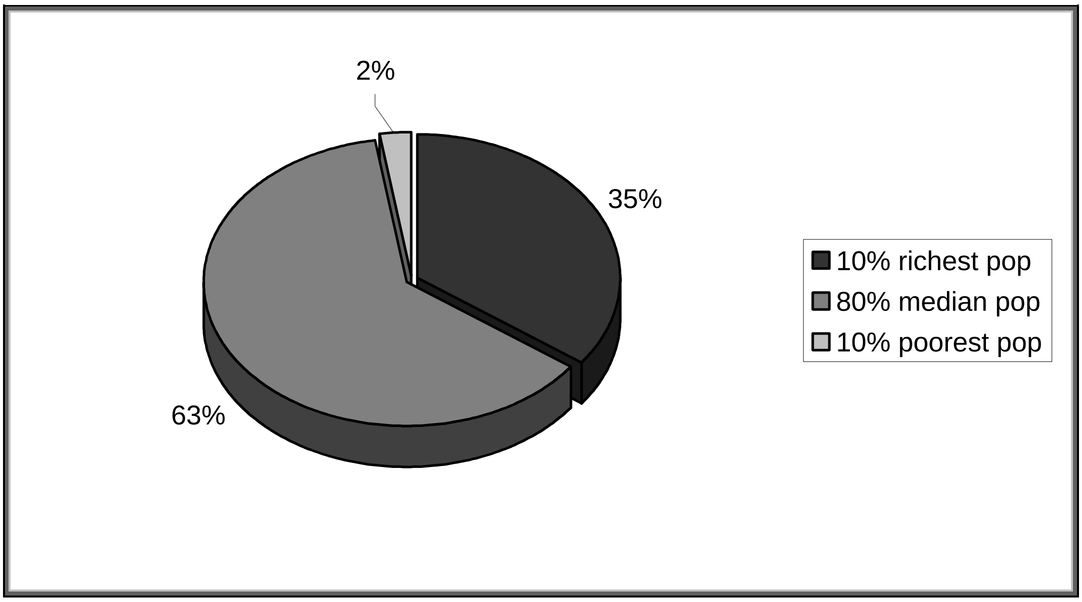

Figure 4.6: Income share held by part of the population in the Philippines (PNUD, 2005)

Since 1980, the economical profile of the Philippines has gradually become more "tertiary". The agricultural sector of the country decreased by 10% of the GDP in 20 years. However, in 2002, the GDP has grown by 4.1% annually. Three sectors are growing very fast: agriculture, trade and telecommunication. By the late 1980s, the workforce engaged in agriculture (75% of agricultural value added), forestry and fishing (25% of agricultural value added) decreased to less than 50%. This was due to two major reasons: low world price and high cost of inputs. Since 1790, with the liberalization of trade, the sugar industry has developed. However, two crops remain dominant in the Philippines: palay rice (unhusked rice) and coconuts. Rice is the largest share of value added products and coconuts are an important income for rural areas.

In 1988, palay and corn occupied 50% of the total agricultural production, coconuts 25% and the remainder was assigned to sugarcane, pineapples and bananas (the last three were however very important for foreign exchange). Despite the importance of rice production, the Philippines do import some rice for their own subsistence.

Before 1565, the system was dominated by 'communal property'. Each Barangay owned a certain amount of land and each family had usufruct on plots with exchange of services. At that time, there was no pressure on land. In 1565, the system was based on private property. Owners, such as Spanish employees, clergyman and the military, were able to purchase a title deed. In the 19th century, the foreign demand for export became more pronounced so increasing the demand for land. With land becoming scarcer, ownership by the rich owners and unequal distribution, the situation for small farmers became unstable.

For these reasons, several presidents proposed agrarian reforms with the most important of these being the reform introduced by Marcos (1970). A law was

established with crucial points but was not applied, as there was instability in the country with martial law being implemented by the president.
In 1987, the Comprehensive Agrarian Reform Program was established by Aquino with the aim of: "Providing welfare for farm workers, social justice and sound rural development on owner-cultivated economically-sized farms" (ROEGIERS, 2002). Lands were redistributed with help being given to farmers embarking on farming activities.

In 28 years, 66% of the total land area has been redistributed. 30% is owned by private owners. Globally however the reform seems to be a failure. Private land owners appear to have developed strategies for bypassing the reforms. These strategies include conversion of agricultural lands into residential lands, division of big parcels into small parcels and threats to farmers and government.

Many problems in the Philippines is like in China due to the inefficiency of the government[1] is one of the major sources of problems in the Philippines, as shown in the following figure (Figure 4.7) where it is obvious that the government has no credibility moreover people have negative confidence on the laws[2] :

---

[1] *Government Effectiveness (GE)* – measuring the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

[2] *Rule of Law (RL)* – measuring the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence (KAUFFMANN et al, 2007

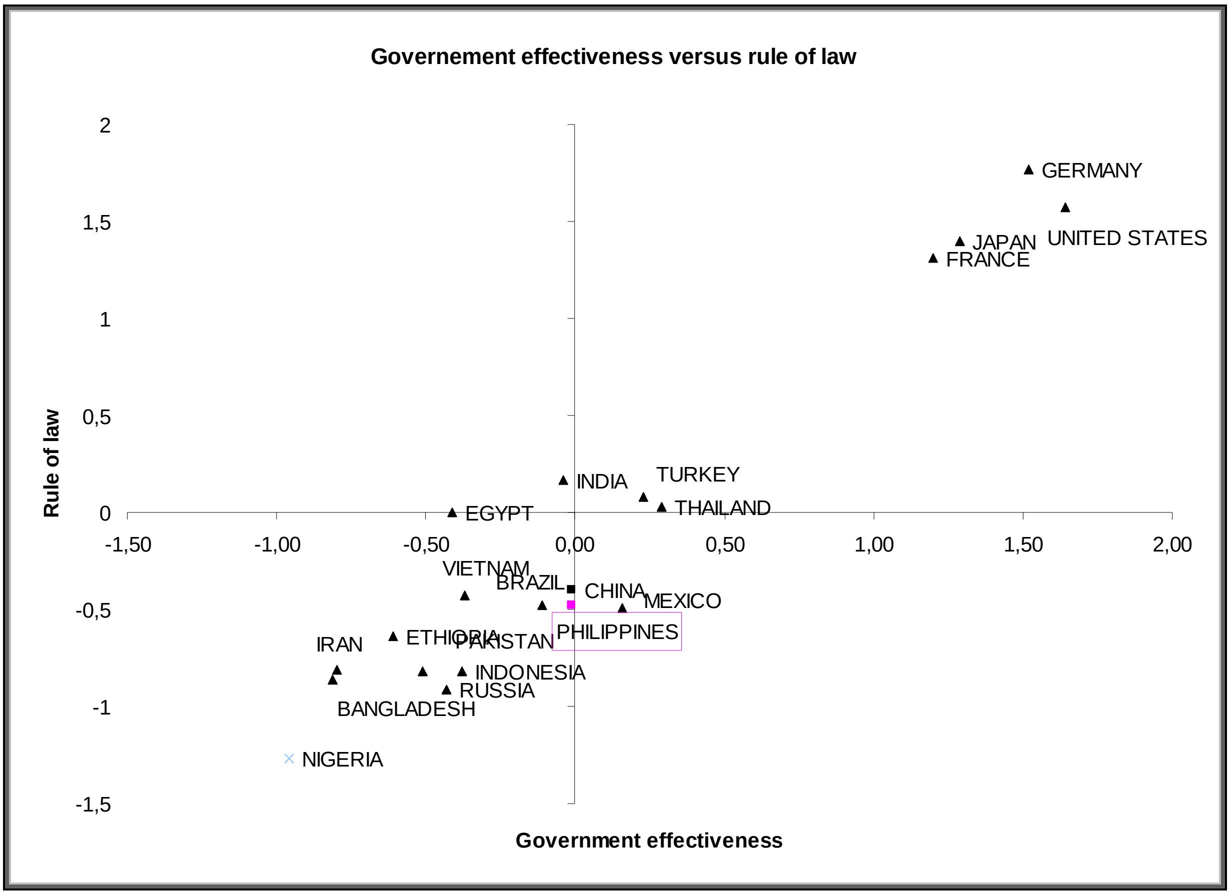

Figure 4.7: Government effectiveness in the Philippines (KAUFFMANN et al, 2007)

Given all this, the Philippines show urgency in addressing fast urban growth areas food security problems.

4.1.3. Environmental profile

Even if the country was one of the first countries to formulate its own 'Agenda 21'[1] process, through a highly participatory process, the Philippines is still undergoing the process of industrialization with all the correlated consequences. Rapid urbanization, industrialization and a weak natural resource management system have created serious problems of environmental degradation in the country.

The country has to face several problems such as the conversion of forestlands and grasslands into urban use. Due to the lack of agricultural land, the population are forced to cultivate on fragile areas causing soil erosion (WORLD BANK, 2002).

Another consequence of this situation relates to SW, as only 16% of the waste generated by the current urban population is properly disposed in controlled

---

[1] **Agenda 21** is a programme run by the United Nations (UN) related to sustainable development. It is a comprehensive blueprint of action to be taken globally, nationally and locally by organizations of the UN, governments, and major groups in every area in which humans impact on the environment. The number *21* refers to the 21st century (http://www.un.org/esa/sustdev/documents/agenda21/index.htm).

dumpsites. This low percentage has many consequences such as health problems due to scattering waste or vulnerability to flooding. This will increase due to the increasing population of cities. Projections for the next 15 years indicate that an additional 12 million poor people in cities will generate 4000 more tons of daily waste to collect and dispose of (WORLD BANK, 2000).

In view of this situation, the country is experimenting composting and UA. A composting project in the Philippines and especially in Marilao (Manila) has already been launched to reduce poverty. The compost is produced with the biodegradable waste generation of households, public markets and small-scale enterprises. The families themselves have learned how to grow vegetables in composted soil that they harvest to feed their families or to sell to the local market. Therefore, they have benefited enormously and reduced their food expenditure. This is also a sustainable project as the excess compost production can be used for replenishment. The potential production can feed Marilao and can also serve markets in Metro Manila, for example (AQUINO and BATAC, 2003).

Some UA projects have been launched in Cagayan de Oro, Mindanao, Philippines, in order to reduce poverty and food insecurity. In the Philippines, allotment gardening represents: "a farming system which combines different physical, social and economic functions on the area around the family home" (DRESCHER A, HOLMER R., 2007).

All this makes the Philippines a country of priority for our research implementation.

4.2. Bacolod City

One of the reasons for choosing the city of Bacolod as a pilot site for this research was because of the strong links between FUNDP and Saint La Salle, the Lasalian University of Bacolod. In July 2001, the two NGOs belonging to the universities, FUCID (Namur, Belgium) and Balayan (Bacolod, Philippines) signed a partnership agreement. The latter has the objective to promote "social responsibility and involvement among the members of the institutions as well as with the local communities" (extract of letter written by F. Orban and C. Villanueva addressed to the Mayor of Bacolod, in November 2001). Balayan is a valuable partner in terms of its relationship with local communities, which has been reinforced through involvement in several projects.

In addition to this, several other factors were important in choosing Bacolod. The LGU of Bacolod City has a highly successful relationship with local communities. As a result, Bacolod received "the Philippines Regional Municipal Development Program (PRMDP)", an infrastructure development capability-building project, financed by Australia.

The technical maps and data used in the thesis come from the department of urban planning of Bacolod City. The technical dialogue about GIS is the same between all the partners.

The analysis of the Bacolod situation is principally based on the Comprehensive Land Use Plan of the City dating from 2000.

4.2.1. Geographical profile

Bacolod is located on the northwest coast of the Province of Negros Occidental and is the capital of the Province thus lending it important status. Bacolod, with a total of 16.145 ha is composed of 61 barangays (Figure 4.8). Barangays 1-41 and 10 others are labeled as urban areas or those situated in the city proper, or ‘poblacion’ and the remaining 20 barangays are labeled as rural barangays. There are 639 puroks (smallest statistical units) in Bacolod City.

It is bordered in the northwest by the city of Talisay, in the northeast by the city of Silay and town of Victorias and in the east and southwest by the town of Murcia.

Due to the presence of the sea, the city is located on a slightly sloping area, with only 0.9% to 5% maximum in the suburbs.

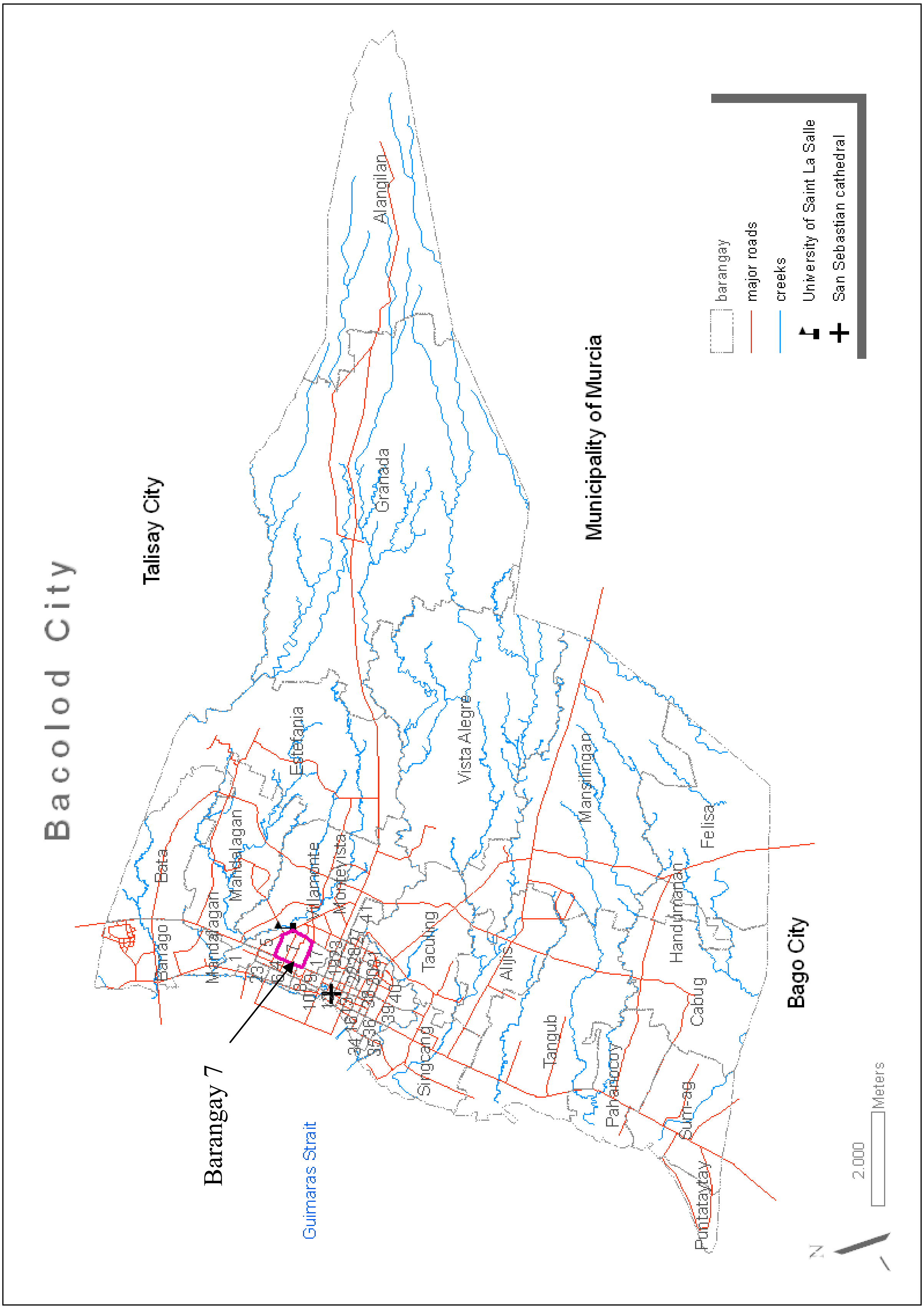

Figure 4.8: Location of Bacolod City and its 61 barangays

As shown in the following figure (Figure 4.9), land use is dominated by agricultural and residential lots.

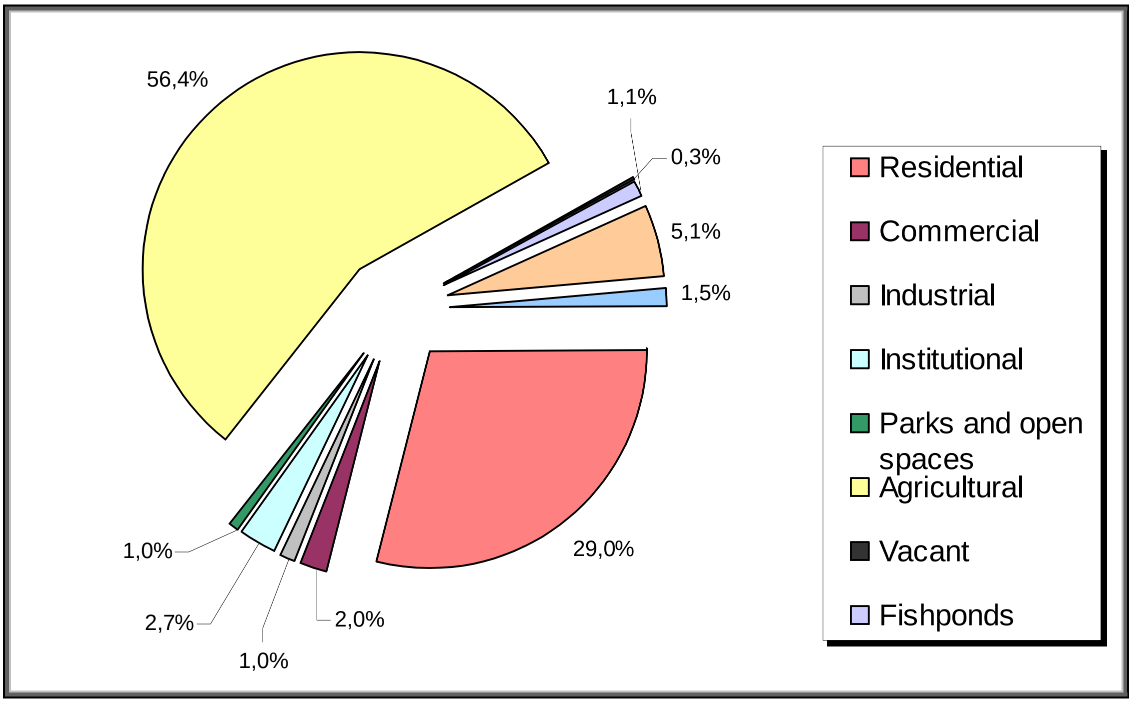

Figure 4.9: Land use in Bacolod City (Bacolod City, City Planning and development office (CPDO), City development council, 2000)

Mot agricultural land is devoted to sugar cane plantation followed by rice. Fishponds are also included in agricultural lands and are mainly located in costal barangays.

Most of the residential land is located within the Central Business District (C.B.D.) and in the North part of the city. In the CBD, most of the land is devoted to commercial purposes along national roads. This is also true of the industrial zones. In Bacolod City, heavy industries are present like a gasoline depot, warehouses, a power generator, steel factories and foundry shops. Near the CBD, land is also used for institutional buildings such as schools, universities and the three major city public markets.

4.2.2. Socio-economic profile

With nearly 500,000 inhabitants, Bacolod remains one of the most densely populated cities in the province and is one of the most highly urbanized cities in the Philippines. In 2007, the city there was an estimated density of 2,657.6 inhabitants per km² (NSO, 2007). This figure is predicted to increase to 3,355 inh/km² by 2010. The growth rate was estimated at 1.39% for the year 2002. The population is growing relatively slowly, with the annual growth rate being on the decline; nevertheless, poverty and inequality are widespread in the city.

Because of the increasing population density, the relatively high proportion of squatters resident in the city is a major concern. At least 30% of squatter communities are located in insecure zones, such as riverbanks. For example, in CBD and Barangays 1 to 41, density was 195 persons per hectare in 1995 and 223 persons in 2000.

These results reflect the scale of the problem in Bacolod City, where 27% of households occupy land without the owners' consent, or fall into the 'Others' category. The problem is acute in the urban barangays, where 33% of respondents occupy land without owner consent or under some other arrangement. The Asian Development Bank reported in 2003 that while half of the population now lives in urban areas of the Philippines, this figure is expected to reach 60% by 2010 (BACOLOD CITY, GIS CITY PLANNING, DEVELOPMENT OFFICE, 2005).

People are attracted by the economic opportunities that they cannot find in other municipalities or cities elsewhere in the province. Because of this growth of population due to migration and births, several problems appear, such as unavailability of land, lack of food or squatters. In the CLUP, considering this problem, city-managers see other cities in the neighborhood of Bacolod as places that can absorb the overspill of Bacolod's economic growth. The average number of families per house in Bacolod City is 1.37. Once again, urban households are more highly populated, having an average of 1.63 families per household. Rural households have only 1.25 families per household on average.

Bacolod is a hub for agricultural products that come from neighboring towns and cities, as well as from the province. Since the price of sugar fell, sugar farmers have embarked upon product diversification such as mangoes, cut flowers, ceramics and eco-tourism. Therefore, for its survival, Bacolod has had to import agricultural products such as rice, vegetables and spices from neighboring islands even though some barangays do produce vegetables. The present agricultural offering does not meet the needs of the population. For example, in 2002, the city produced 3,502 tons of rice while the basic food demand for Bacolod City was 46,000 tons (Figure 4.10).

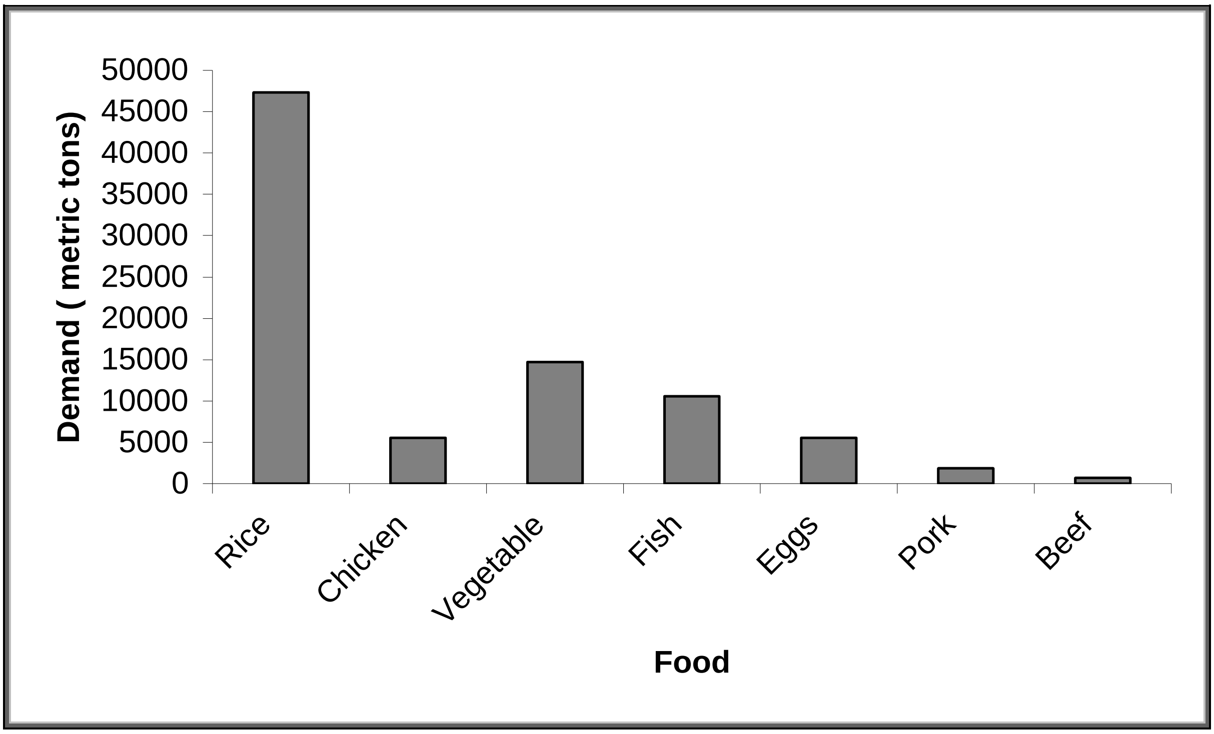

Figure 4.10: Basic food demand in metric tons in Bacolod City (BACOLOD CITY, CPDO, RESEARCH AND STATISTICS DIVISION, 2002)

Therefore, the city has had to import goods for its subsistence. This situation will only worsen in the future.

According to the opinion of the Government, Bacolod has some suitable soil for production of primary crops; UA might therefore be one means to address food security.

The major crop is sugarcane (7027 ha in 2001), followed by rice (1246 ha in 2001), vegetables (198 ha), root crops (156 ha), coconut (120 ha), corn (53 ha) bananas (45 ha), spices (35 ha) and orchards (31 ha) for Bacolod City (Figure 4.11). This figure establishes clearly that Bacolod produces more export-oriented food than subsistence food specific from many developing countries.

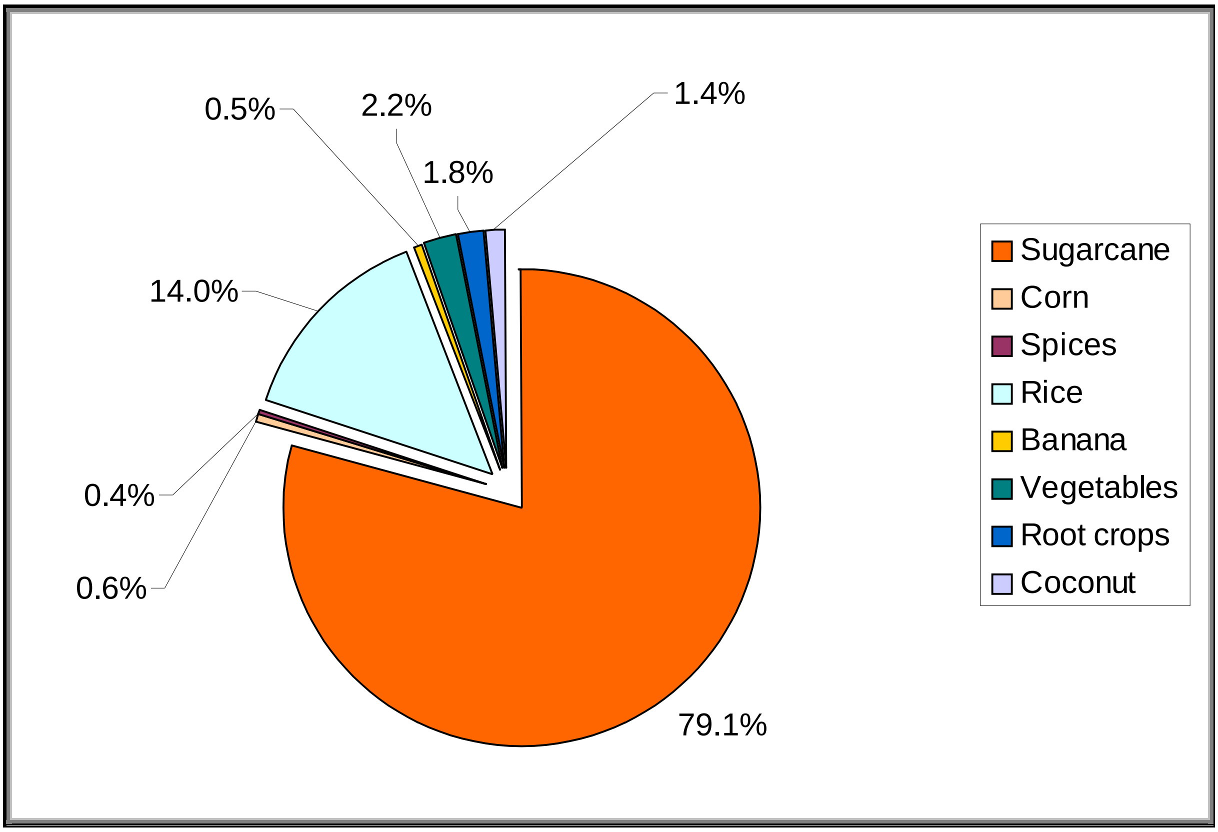

Figure 4.11: Bacolod city agricultural lands affectation (Bacolod City, CPDO, City Development Council, 2000)

Commerce and trade provide employment for 10% of the population in Bacolod. Farmers can sell their products through the intermediary of three public markets: Central Market, South Public Market and the North Public Market. However, smaller markets also exist in the barangays. These markets are the starting point of economic development for Bacolod, but encouraging participation of small agri-based producers in trade fairs outside of the city is another important step.

The City of Bacolod agrees with a system of sustainable development based on social equity, reduction of poverty and provision of employment. An equitable development of people and an ecological development of the environment is seen by the city government as being in keeping with regional development.

However, the major challenge for the economic sector remains the need for investment and employment opportunities in order to improve people's quality of life and to act as a stabilizing factor. In addition, as envisaged by the CLUP, the city would like to strengthen competitiveness in areas of privatization, which may allow private initiatives to grow and flourish in Bacolod. It appears that awareness is increasing regarding urgent matters such as poverty alleviation, income improvement and stabilization of agricultural land conversion.

4.2.3. Environment profile

Some of the residents of Bacolod are concerned with composting, in accordance with the Republic Act 9003[1]. Composting in urban households is not as common as in rural households, only 18% or the urban household practice composting and the double percentage for rural households. This is probably due to space constraints in urban areas, and the improved services that urban areas receive from waste management facilities. One of the benefits of composting is being able to sell it. The average price per kilogram of compost is PHP 5.25, but prices range from 3 PHP to 6 PHP per kilogram (BACOLOD CITY, GIS CITY PLANNING, DEVELOPMENT OFFICE, 2005).

Another more common practice is recycling. According to a survey, for 20% of the households interviewed in Bacolod City, this practice is boosted by the monetary incentive of buy-back systems. Others practices are present in the city like burning waste or disposing of it without segregation. Moreover, 15 dumpsites exist in Bacolod posing a variety of threats to the surrounding communities. In the city, the Department of Public Services is in charge of the SW collection and disposal, while the SWM Division undertakes waste collection and disposal. It serves rural and urban barangays and private subdivision.

A number of barangays have reported environmental issues in their local area. A total of 15 rural barangays and 27 urban barangays identified foul odors, polluted and unfenced waterways, illegal waste disposal and other issues of concern.

Pollution represents an important problem in large cities, like Bacolod. The latter had a population of 100,000 inhabitants in 1960 and 40 years later, the population has quadrupled (Figure 4.12).

---

[1] An act providing for an ecological solid waste management program, creating the necessary institutional mechanisms and incentives, declaring certain acts prohibited and providing penalties, appropriating funds therefore and for other purposes. (http://www.lawphil.net/statutes/repacts/ra2001/ra_9003_2001.html)

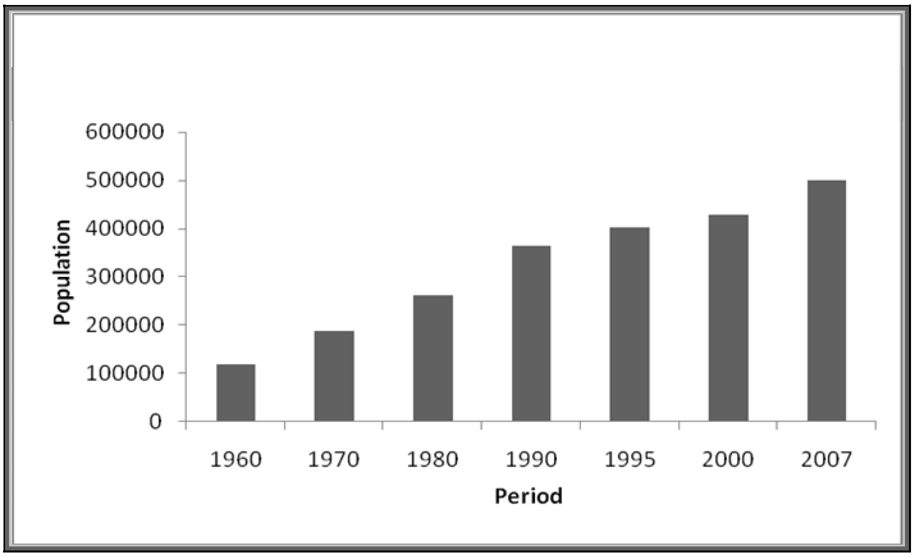

Figure 4.12: Bacolod population growth (BACOLOD CITY, CPDO, RESEARCH AND STATISTICS DIVISION, 2002)

During the period between 1988 and 2002, the amount of garbage has undergone the same growth and occupies a volume of 243.066m³. In 2001, the volume was 209.495 m³.

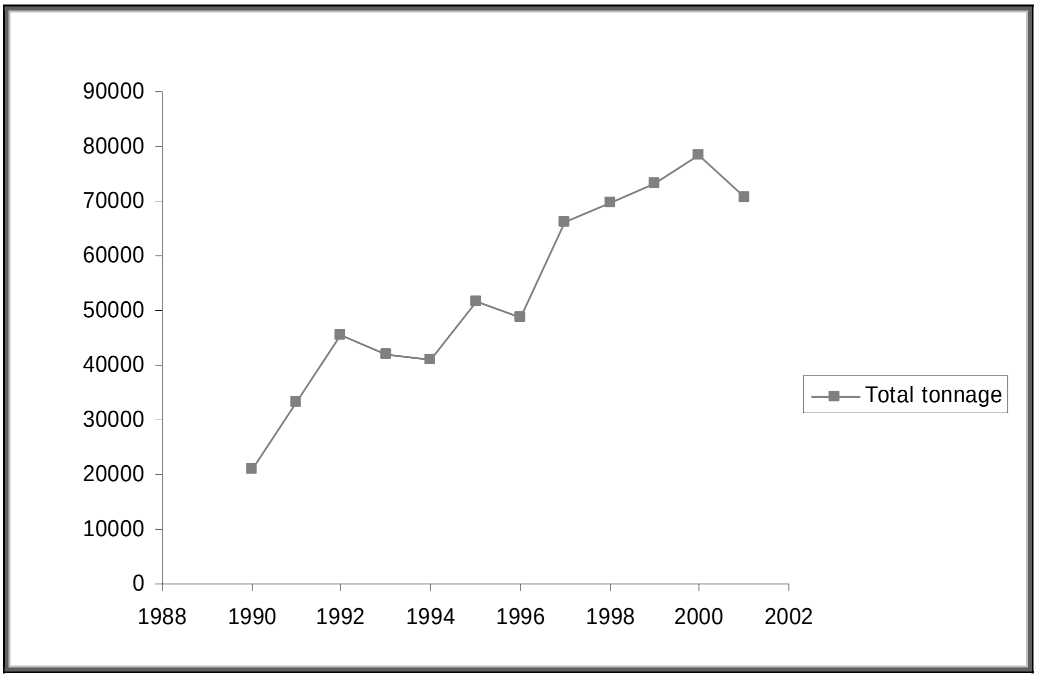

Figure 4.13: Total volume of garbage, in tons, collected/disposed in Bacolod City during 1990 and 2001 (BACOLOD CITY, CPDO, RESEARCH AND STATISTICS DIVISION, 2002; http://perspective.usherbrooke.ca/)

This rapid increase may be explained, among others, by a change in lifestyle, such as eating in fast-food restaurants (HOLMER, ANSELMO, SCHNITZLER, 2001). Indeed, pollution affects agricultural lands and therefore affects productivity. The expansion of economical activities also creates a problem of waste production. Before the government could react to the problem of pollution, a huge number of discharges were created all generating pollution. In this context, the city government needs to promote a waste disposal system, which takes into account collection, transport and disposal of garbage.

The highest percentage of material is composed of degradable organics (43.9%) among others (Figure 4.14).

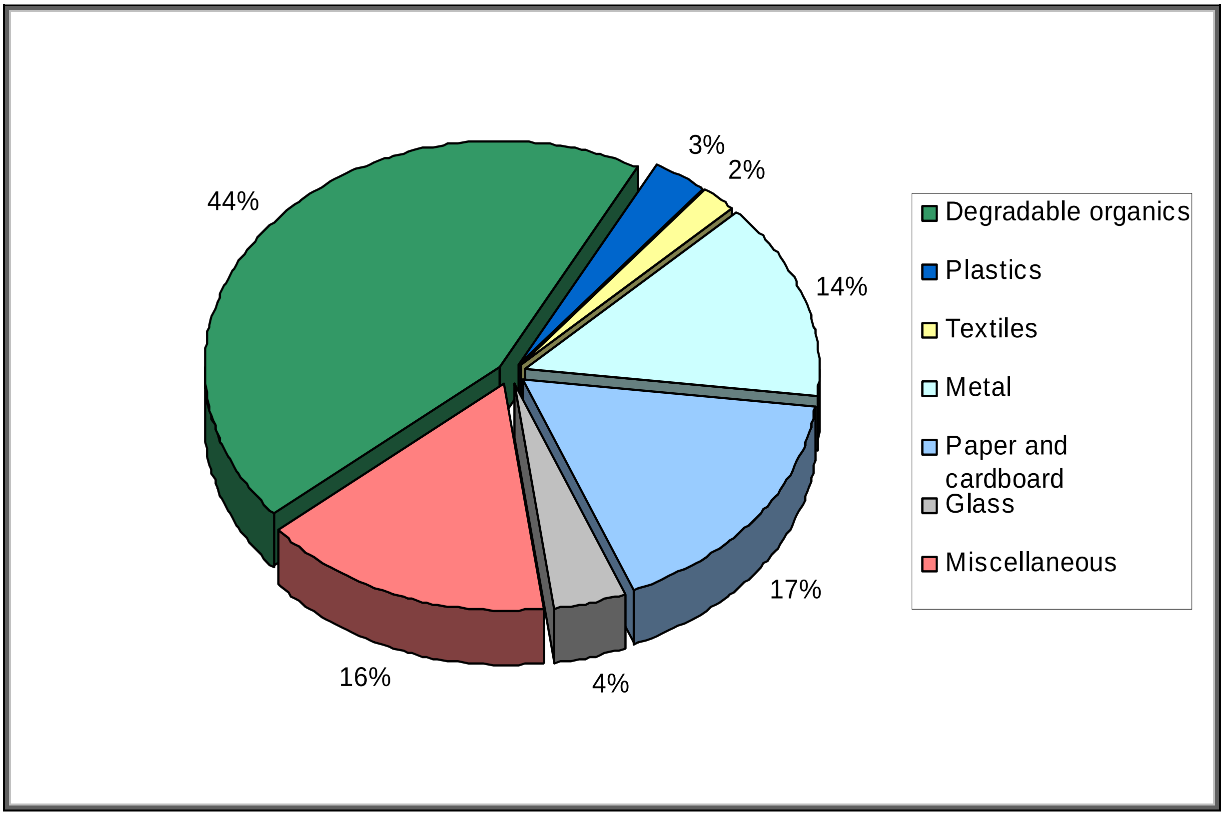

Figure 4.14: Waste characterization of Bacolod City (BACOLOD CITY, CPDO, RESEARCH AND STATISTICS DIVISION, 2002)

With the help of the Australian funding body AusAID, a certain awareness of the problem has emerged. Therefore, several training programs have been conducted and the city has created the SWM Board. "*The board is in charge of planning the implementation of Landfill in the City*" (BACOLOD CITY, CPDO, CITY DEVELOPMENT COUNCIL, 2000). The proposed site is in the South of Bacolod City; however it is currently classified as agricultural land and must be classified as ecological land prior to use as a landfill.

Finally, in order that Bacolod can keep its title as the "cleanest and greenest" highly urbanized city in the country a program of reforesting has been implemented.

4.3. Barangay 7

Barangay 7 (Figure 4.15) was chosen as local partners indicated a high motivation among its population for SWM and pervasive poverty. Local communities are fully integrated in several projects and open to all data sharing due to strong links established nearly 30 years ago with Balayan. In 2002, in this Barangay, a center for waste segregation was opened, another ideal component for a SWM motivation.

Directly related to the context of UA, allotment gardening has been produced in Barangay 7 and more specifically in the Purok Magnolia.

4.3.1. Geographical profile

Barangay 7 occupies a total of $0.4 km^2$ in the northwestern part of Bacolod City. The Barangay 7 is composed of four puroks: Coca-Cola, Magnolia, Repolyo and Tangkong (Figures 4.15 and 4.16).

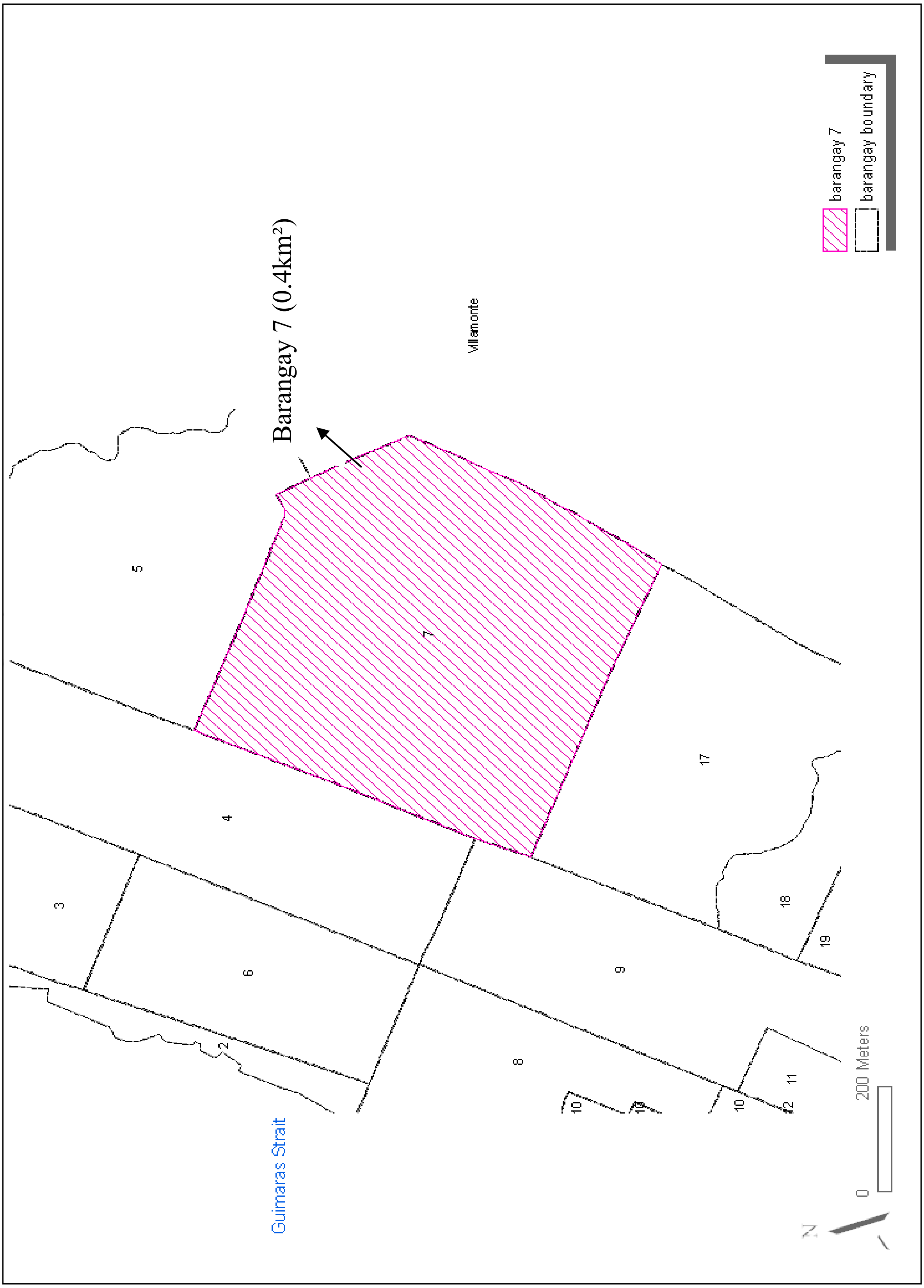

Figure 4.15: Barangay 7

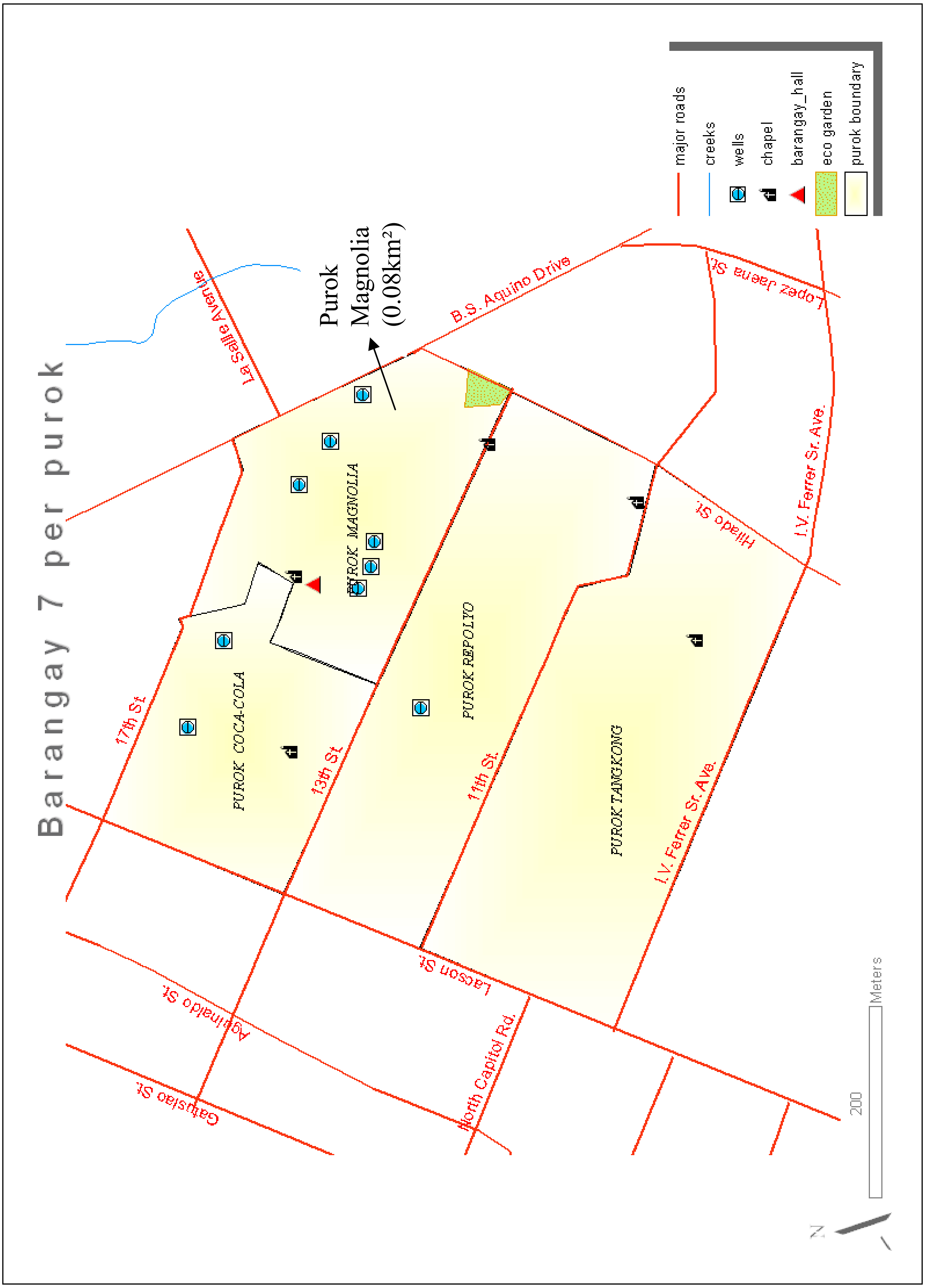

Figure 4.16: Barangay 7 per purok

4.3.2. Socio-economic profile

Barangay 7 is classified as an urban poor barangay. Urban households are more densely populated, with an average of 5.6 people in each household compared to an average of 5.19 people living in rural households (BACOLOD CITY, GIS CITY PLANNING, DEVELOPMENT OFFICE, 2005).

The population of the Barangay has grown by 2% in five years, which is relatively slow compared to 18% growth in Bacolod City.

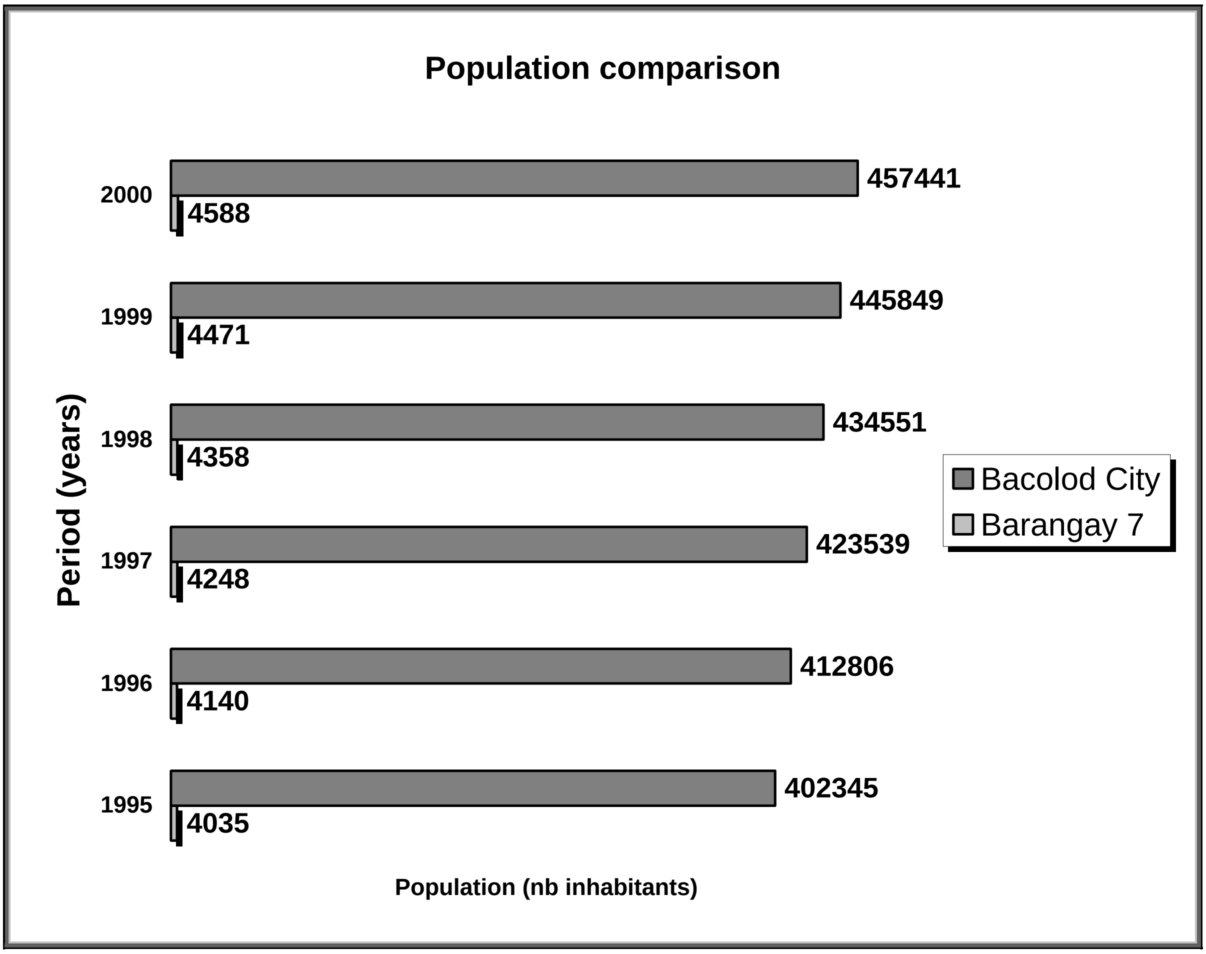

Figure 4.17: Population comparison between Bacolod City and the Barangay 7 (Bacolod City, CPDO, City development council, 2000)

In Magnolia, comprising approximately 275 households or structure owners, several households contain “sharers” or family members and, such households can be considered as an extended family. Regarding income in this purok, 40% of the residents can be considered as regular income earners employed in the private and public sector. Casual earners and periodic workers constitute 30% of the active population; the remaining percentage falls into the unemployment category.

The vast majority of the populations, 70%, have attended secondary schools; a little more than 10% have attended college and 5% are college graduates or professionals.

Many residents of the purok have been active in government participation. They were and are still open to and cooperative in projects and programs provided by NGOs and the government; their aim being to improve and stimulate life in the purok.

4.3.3. Environment profile

Barangay 7 saw a decrease of 15.2% in its population between 1995 and 2000. At the same time, the total amount of garbage was 341.25 kg in 2000 (Figure 4.18).

Since June 2003, a common site with collective bins has been opened. This is the barangay redemption centre. In order to be effective, a lot of training has been given to local people and billboards have been erected providing information about waste segregation. The local NGO has performed one of the most important tasks of waste management, often neglected in developing countries, which consists of educating the people.

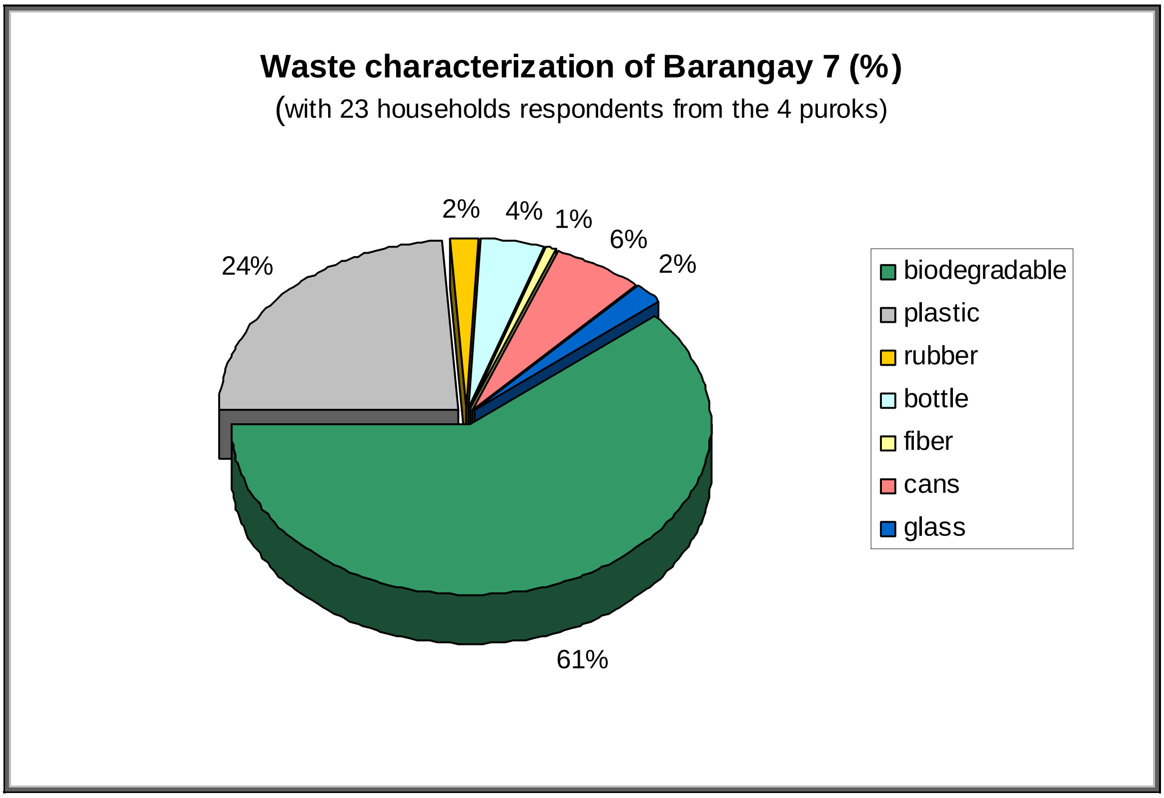

Figure 4.18: Waste characterization in the Barangay 7 (Bacolod City, CPDO, Research and statistics division, 2002)

The purok Magnolia especially has been involved in the project of SWM with Balayan and Bacolod City. This program aims to promote and implement proper waste segregation, collection of recyclable materials, composting and UA.

Chapter 5. Methodology elaboration

The methodology used in this study was adapted from a specific City-to-City Asia Urbs project funded by European Commission. "The Asia Urbs Program is one of decentralized (city-to-city) co-operation with elements of technical and economic co-operation, capacity building, partnership development, good governance, and poverty alleviation" (http://www.hanoi.irisnet.be/programme_en.htm).

Pilot projects are co-funded by the Program and encouraged to exchange information and experience through networking and Asia Urbs Seminars. In this way, the Program aims to promote the lessons learned from mature pilot projects and to initiate the development of new urban partnership projects. There is also scope for replicating successful projects, and promoting South-South co-operation." (*http://europa.eu.int/comm/europeaid/projects/asia-urbs/about_asia_urbs.htm*). The specific Asia Urbs project that inspired the current research is called "GIS-based Urban Environmental Resources Management and Food Security Project" (Asia Urbs project, PHL-3-17); it focused on Cagayan de Oro, in the Philippines. The project has been conducted under the supervision of the department of geography of the FUNDP (Belgium).

In the city of Cagayan de Oro (cf. Chapter 7), in 2002, the Asia Urbs pilot project aimed to assist city barangays in the implementation of the "Ecological Waste Management Act", essentially oriented through garbage segregation at the household level. The establishment of allotment gardening was the second component of the project. The implementation of a GIS-based environmental data bank through a participative process was the third objective of the project. As the objectives of the Asia Urbs project were similar to ours, our methodology was adapted from that European project. A concrete collaboration between both groups of scientists helped to create the first cartographic phase of our methodology.

Specifically, the elaboration of the linear weighted equation of the Environmental Social Community (ESC) phase of the methodology (Figure 5.1) was inspired by the Asia Urbs project with specific original adaptation.

The Statistical-Spatial Index and Profitability Survey phases of our research represent some significant parts not found in the Asia-Urbs project.

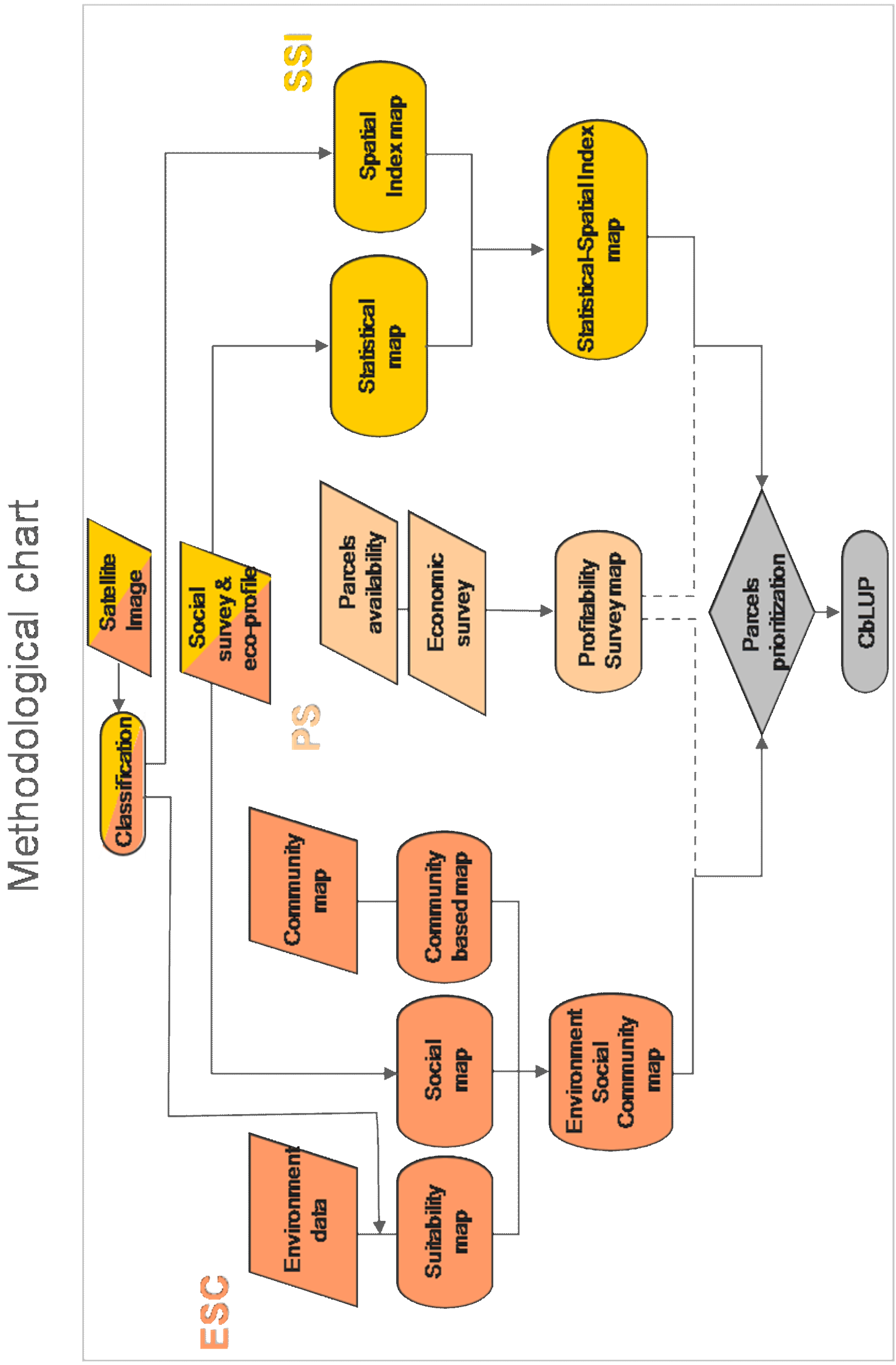

Figure 5.1: Methodological chart

As introduced in the second chapter, two approaches were used to select plots adequate for urban gardening and to produce a CbLUP :

The first approach, Environment-Social-Community (ESC) started with a Suitability Map for UA, with a social survey used for the creation of a Social map through GIS. These maps, combined with a Community-based Map, produced through a community map activity, represent the outputs of the ESC approach.

The second strategy for selecting an adequate zone was based on the elaboration of a Statistical-Spatial Index (SSI) map through a specific statistical method and the computation of a Spatial Index. The SSI methodology represented a second way to select plots in targeted zones such as the poorest zones, those motivated for waste management or skilled in agriculture.

Finally, those selected plots potential was estimated via a productivity analysis and produced a Profitability Survey map (PS).

The selected plots and their priorities are the basis for the proposed scenario for the Community-based Land Use Plan (CbLUP). As the objective of the thesis was to provide decision-makers with a management tool, a Community-based Land Use Plan was proposed. A plan created through the research was felt to be more oriented towards the benefits of SWM and UA, and the perspectives and needs of the communities could be included.

The CbLUP was composed of different maps formed with various weighted combinations of ESC, SSI and PS maps. Several scenarios were presented to the decision-makers as they represented the last stage in the decision-making process.

Starting with a large scale (a small area) allowed evaluation of the feasibility of the methodology to reach the predefined objectives. This methodology was therefore first applied in Barangay 7 and replicated in a larger city of the Philippines (cf. chapter 7).

5.1. Environment Survey Community approach (ESC)

The steps of the ESC methodology are the building of :
- a suitability map for UA ;
- a social map based on a social survey ;
- a Community-based map.

The combination of these three pre-cited map was used to create an Environment Social Community map.

5.1.1. Suitability map

The creation of a suitability map was realized through different approaches: agronomical, physical and accessibility. The optimal location of the plots was evaluated through a location analysis or suitability analysis. As the plots should meet very specific sets of criteria, it also referred to MCDA.

A suitability map therefore represents the biophysical identity card of each plot of the study area without social aspects taken into account.

Once the criteria were finalized, the most adequate plot in this case for UA met all criteria. Nevertheless, the criteria could also be ranked or weighted. In ranked model, criteria are classified in an ordinal way. Since a given number represent the same degree of adequacy for UA, the range of criteria values can thus be added and averaged, resulting in a more nuanced assessment of adequacy.

Weighted models allow experts designate one criterion to be more important than another does as a meaningful way to answer central question. It is a form of importance ratio. The criteria which have been rated are weighted and then added to the other criteria and averaged by the sum of their weights.

The general process is based on a simple weighted mathematical linear model or multicriteria evaluation model. In the model, factor, constraint and parameters are present:

<u>Factor</u>: a criteria defined in all geographical positions, classified regarding classification rule and weighted

<u>Parameter</u>: “a value which is constant in the case concerned but may vary from case to case where a case can represent a different model run or different grid cells or objects within the same model”.

<u>Constraint (C_i)</u>: a defined mask to exclude non-possible areas (forbidden land use, etc.) The global equation is set out this way :

$$\Sigma \left((\text{weight} * \text{Factor}) * (\Pi * C_i)\right)$$

The data were standardized to avoid size effects. In all the GIS process, values are standardized from [0 → 1] through: $[\text{normalized value} = (x - x_{min})/(x_{max} - x_{min})]$.

In the ESC methodology, all factors were combined and weighted. Weights were established based on discussion with local partners. In the ESC approach, the selected criteria were :

- Accessibility to :
  - Wells;
  - Pathways;
  - Houses;
- Land suitability;
- Water quality and quantity.

The suitability index was composed of these criteria:

$$\text{suitability index} = \alpha * \text{accessibility} + \beta * \text{land} + \gamma * \text{water}$$

5.1.1.1. Accessibility

In order to be the most suitable plots for UA, the accessibility was computed since perishable and highly value added vegetables are usually produced.

In the extension proposed by ArcMap the function Euclidean distance is used and especially, the straight-line distance. This straight-line distance function has been chosen since the objective of the accessibility index is to find the distance from wells, pathways and houses.

The Euclidean distance output raster contains the measured distance from every cell to the nearest objects such as wells. The distances were measured as the "crow flies" (Euclidean distance) and computed from cell centre to cell centre. The accessibility index was the summation of all the computed straight-line distance.

The selected plots were those that combined the lower distances' sum to each selected criterion: wells, pathways, roads houses and markets. Each distance from criteria were standardized from 0 (highest distance to criteria) to 1 (smallest distance to criteria).
Some postulates were integrated in collaboration with the local NGO's and local biophysical experts:
- Wells are the major water source for local people;
- Pathways are important for local communities;
- Houses have to be as closest as possible in order to limit the time dedicated to walk; a maximum walking distance is 3km per day is established;
- Markets are the only places to sell vegetables.

Accessibility = wells' distance + pathways' distance + roads' distance + houses' distance + markets' distance

1) Wells

The objective of the accessibility map was to give the distance to the nearest well or any source of water; the nearest well is being designated 'the best'. Wells are crucial for vegetable growth especially in a country such as the Philippines where there is a dry season .

2) Pathways (eskinitas in Filipino dialect) and major roads

Pathways are the most used walking routes in the Barangay due to inadequate roads. In addition, pathways are useful due to the narrowness of the area.

3) Houses

The location of their own houses is important as if people spend less time walking they gain more time for cultivating.

4) Markets

Markets are essential for selling own-made products and for providing gardeners with a regular income.

5.1.1.2. Land

The land equation considers elements related to the soil. In such an equation, some variables were considered as constraints, such as the highest slope or polluted soil. This is also, as for the accessibility map, a combination of weighted criterion. The criteria should be ranked as, regards UA, a slope of 0.55% could be 10 times better than a steep slope of 10%.

In the last part of the equation a specific methodology for remote sensing was used: object-oriented classification of a high resolution remote sensing image.

$$\text{Land} = \alpha * \text{soil} + \beta * \text{water} + \gamma * \text{land use}$$

1) Soils, Slope, Flood Prone Areas and Plots Size

Soil type was a raster layer that classified all cells (3.15 m) as one soil type or another. This raster was not only based on an existing soil type layer but also took into account soil fertility and acidity.

Given that agriculture has to be practiced, slope is an added criterion since if the area is steep, more land settlement is necessary. Slope considered classified range of slopes and excluded all cells greater than a given value. Therefore, the layer was both a variable and a constraint.

In the Philippines, periods of flooding are important during the monsoon and it is difficult to cultivate during this time. Therefore, the flood layer masks all cells prone to flooding identified by local communities.

Size layer masked all small plots with a surface area less than 400 m2. This condition is imposed by the allotment gardening working group of the Asia Urbs project that identified the smallest useful plot of land that is likely to be used for any one household.

2) Water

In allotment gardening studies, water represents a crucial element in the equation. The quality, quantity or cost of water resources may be analyzed. If water is in low quantity, gardeners may bring it from other sources or may make many management works. Moreover, if water is polluted, vegetables may be unsafe for consumption with negative implications for consumers' health. A quality and quantity value is given to all areas before its integration into the model.

3) Land use

The main objective of the elaboration of a land map was to consider the types of land use that are adequate and legally authorized for the implementation of UA. Land Use layer masks all rejected land uses and only considers possible areas related to the objective of the study as open lands.

The land map was elaborated with a reclassification of a raster composed of the land use classes.

A. High resolution image

Problems created by urbanization can be analyzed by the use of remote sensing. This technique may represent a link between people, landscape characterization and spatial representations. It seems to be more evident in developing countries because they are not capable of supporting the sustained and publicly available record keeping and data maintained by industrial cities (MILLER, 2003). One of the advantages of this technique, that is by no means negligible, is the use of time-series images used to solve spatial-dynamic problems.

Wilkinson agrees with the fact that GIS and remote sensing are complementary in terms of modeling, analysis or as ancillary information (LONGLEY and BATTY, 1996). Urban analysis in remote sensing is a challenge in terms of land classification. Some scientists even question the operational usefulness of urban remote sensing because of the difficulty of spectral discrimination in the urban context. Authors like Paulsson (1992) think that remote sensing should not be used in isolation. Other sources of information or mapping techniques are essential for the evaluation of the results.

Classifications in urban contexts seem to be very poor since similarity of urban land cover types caused by inappropriate resolution dimension and surface variability and heterogeneity, high-resolution image, i.e. lower to 5 meters, is one of the proposed answers.

As explained before, city planners, in the context of a high degree of urbanization and residential development pressure, need up to date and consistent information. Previously, the visual interpretation of very high-resolution aerial photographs was applied but it was very time-consuming and very expensive. Nowadays, the utilization of high-resolution images from satellites is increasingly widespread. The principal reason for this application is linked to the definition of the "urban land use" concept. It is a complex phenomenon, social and economic, defined more in terms of function rather than form. "*Thus the relationship between land use in urban areas and spectral* *responses recorded in images is very complex and indirect, precluding the use of traditional classification approaches*" (BAUER and STEINNOCHER, 2001). Therefore, an alternative approach, in two steps, is proposed: extraction and classification of image objects.

With a satellite such as Quickbird, a product called a "bundle": panchromatic (61 cm) plus multispectral (2.8 m) resolution may be acquired. A combination between the advantages of a real high resolution of a black and white image, useful for the characterization of urban infrastructure and plots, and the advantages of four bands images (blue, green, red and near-infrared image) is possible. Globally, to produce this type of image, sigma filtering is applied to the multi-spectral band where the filter behavior is controlled by the panchromatic image (BAUER and STEINNOCHER, 2001).

Thomson (THOMSON and HARDIN, 2000) has worked on the use of remote sensing to identify potential low-income housing sites. For that purpose, he chose several criteria, as in our GIS-simulations: these included "no flood risk", whether land was near major transportation routes and whether land was government owned amongst others.

With a high-resolution image, like from Quickbird, it is possible also to produce a density housing classification, to assist the land use classification and minimize overlapping between classes. It is obvious in the literature that city have a pattern of declining housing from the city centre to the rural fringe. In order to quantify or give a class to zones, we used a criteria based on the number of dwellings per hectare.

B. Object-oriented classification

Classification in an urban context is rather difficult due to the presence of subpixel mixing. Urban zones are heterogeneous, but this can be solved by the use of an expert system, a system that reclassifies the simple classification. For example, spectral signatures of roads and built areas are similar; in this case, a GIS-layer containing the roads can be applied. High-resolution imaging does not imply high accuracy of classification. This is due to the presence of heterogeneity of the objects. Using traditional methods of classification is not possible in an urban context and with high-resolution image, due to the complexity. Moreover, supervised classification is poor at distinguishing land use, but is good for land-cover. One idea is to assume that "*the land use functions can be distinguished on the basis of the differences in spatial distribution and pattern of land cover forms*" (BAUER and STEINNOCHER, 2001). With high-resolution data, an object-oriented classification can be applied.

Thomas et al (2003) have compared three urban mapping methods using high-resolution digital imagery. In their applications, it seems that using a combination of unsupervised-supervised classification techniques guarantees low accuracy (in the study, only 58% in the fuzzy-error matrix).

One problem often encountered in classification is the discrimination between built and non-built areas. This therefore means that in an urban context we need a specific type of classification method - a feasible means of applying a supervised classification and a non-supervised classification. Another way to work in an urban context is to carry out an object-oriented classification using "rule-based" software where objects and relations between them are considered as necessary to obtain a good classification. Therefore, all object-oriented classifiers classify objects and non-single pixels.

As explained above, it is possible to extract information about object density thanks to the concept of image segmentation. In the software, texture information can be extracted by the way of Haralick indices: homogeneity, entropy, etc...

The texture indices can be computed through two general approaches: the Grey Level Co-occurrence Matrix (GLCM) or the Grey Level Difference Vector (GLDV). The latter is the sum of the diagonals of the GLCM; it "counts the occurrence of references to the neighbor pixels' absolute differences". This one is a "tabulation of how often different combinations of pixel grey-levels occur in an image" (ECOGNITION MANUAL, 2001).

Patch Analyst is an extension of the ArcView® GIS system that facilitates the spatial analysis of landscape patches (cf. concepts and definition in Appendix 1) and the modeling of attributes associated with patches. The software includes capabilities to characterize patch pattern, and the ability to assign patch values based on combinations of patch attributes (e.g., combinations of stand age, over story composition, and crown closure) (PATCH ANALYST HELP, 2002).

5.1.2. Social map

This second map reflects the social aspect of the study, based on a social survey. More specifically, by means of different questions, the socio-demographic profile of targeted households, which are the growers, consumers and vendors of the vegetables, is was analyzed. Moreover, vegetable consumption and waste disposal practices were determined.

All the selected answers to the survey were aggregated into a "Survey-Based Indicator" (SBI) computed for each purok.

The SBI was used to classify zones considering their level of poverty and their social potential for agricultural success: motivation, skills about agriculture, motivation about SWM, lowest income, etc.

5.1.2.1. Survey-Based indicator (SBI)

SBI was composed of five elements that are combined into three main components: level of poverty, apriori capability about UA and SWM and SWM practices already used in the study area. Five elements were selected as they represent clearly the three components through the questions asked to head of household:

- Level of poverty:

  - Income: mean income per household compared to the mean national level of income;
  - People density: the mean income in the purok multiplied by the people density in the purok.

Both are multiplied in order to be combined and to represent the level of poverty

- Apriori capability about UA and SWM:
  - Awareness about SWM or UA: simple binary answer, yes or no;
  - Skills about UA: based on the type of jobs, based on the assumption that some people have good gardening knowledge as a result of their daily current or previous activities.

Both are multiplied in order to be combined and to represent the mental capability of people about UA and SWM

- Garbage practices: based on how people deal with their waste in order to evaluate their motivation about SWM.

The equation is composed of the three main components that are summed in order to be further weighted according to the importance given by local communities:

SBI = Income * people density + Awareness * skills + Garbage Practices

Correlated to the SBI equation, in the following table, the characteristics of the communities with the highest potential are exposed:

Communities with high potential	Communities with less potential
urban poor	rich people
high population density	low population density
agricultural skills of people	other skills
UA and SWM willing	no motivation about UA and SWM

Table 5.1: Social characteristics of targeted communities

5.1.3. Community-based map

This third map was based essentially on a Community Map. The objective of the Community-based map was to compute Community Map information into a new raster layer that integrated the expectations, needs and perspectives of the targeted communities into the model. This was a source of data emanating directly from the communities and expressed directly by them without any scientific intervention. All the drawings from people were digitized using simple forms: point, line or polygon.

This map defined the most attractive area for the communities as the area where the communities draw many significant features. The areas highlighted by the communities were those where all the activities were concentrated and where the population may want to implement an allotment garden if possible.

5.1.3.1. Community map (CM)

Environmental Science for Social Change (ESSC), Malaybalay City (ESSC, CBFMO, DENR, 1998) is the organization in charge of the explanation of the community map philosophy to local experts and communities. Moreover, the organization is in charge of the formation of local experts. On the community map, the communities presented what they wanted to tell the city officials and not what we expected them to draw. They draw the features on four different plastic slides: social-services, SWM, economic and allotment garden.

5.1.3.2. Density of Interest Indicator (DII)

Based on the postulate that if people draw many features on a given spot, they are more attracted to this area, a density of interest of the local communities is computed through the interpretation of their mental representation of their territory. An FGD from the local communities classified features into a few significant categories and attributed different weights to each category.

The total weight of the features was 100 in order to clearly evaluate the impact of each group. The weights, given by the communities, affect the final calculation of the density of interest indicator.

By classifying all the features into four categories, the features are no longer spatial objects but geographical weighted points. By transforming these points with the "calculate density" function of the Arc View spatial analyst, was possible to define, for the entire surface covered by the community map, a "density of interest" that represented how important the area is to the social lives of community members.

The mathematical process which underlies the map is a Density of Interest Indicator. This enabled indication of where points or line features were concentrated, as for example the predicted distribution of the population over a surface. Theoretically "the density function in GIS creates a continuous density surface from a set of input features" (ARCGIS, 2006).

By calculating density, point values are spread out over the surface. The measured quantity of an input feature dataset, the weights of the elements of the CM transformed into centroids, were distributed throughout a landscape, and a density value is calculated for each cell in the output raster. A buffer computation was applied to each cell in the output raster being created. The circular area determined the distance to search for points in order to calculate a density value for each cell.

The density kernel calculation works as a simple density calculation: points or lines that fall within the target area were added and then divided by the area to obtain each cell's density value. With kernel density, points or lines lying near the centre are weighted more heavily than those lying near the edge. The output came as a raster file.

5.1.4. Output : Environment Survey Community map (ESC)

This map represents a global map for the first phase of the methodology. All the aspects are present: environmental, social and community perspectives. This results in a combination of the first three maps produced.

Each element of the three global maps was weighted differently in order to produce different scenarios. Some of them gave more priority to the survey and the community, and were therefore based more on the social aspect of the methodology, while some gave more priority to the environmental aspect.

$$ESC = \alpha*\text{Suitability map} + \beta*\text{Social map} + \gamma*\text{Community-based map}$$

The ESC map is only an addition of the previous maps created with a weighted combination. The choice of the combinations may help to analyze the differences in importance between technical or scientific data and community data. This helps in analyzing the impact of the communities' views and perspectives.

5.2. Statistical-Spatial Index approach (SSI)

In the second approach, the social survey through a statistical method, and land use through a spatial index method, were combined. This second approach was used to confront, confirm or reject results obtained with the ESC methodology. The SSI map was composed of two parts: the Statistical map based on a Principal Component Analysis (PCA) compiled with the social survey data, and the Spatial Index map based on the spatial indices calculation.

The approach centers on the quote "Population living in areas with similar housing conditions will have homogeneous social and demographic conditions" (DONNAY, 2005).

5.2.1. Statistical map

In the Statistical map, the social survey is included in a summarized form.

The information was compiled into the major components of a PCA thanks to a statistical methodology. This is a way to use social information into the study and to give 'identity cards' to each targeted zone. The objective of the statistical method, called Principal Component Analysis, was to summarize the characteristics of the puroks of the studied zone and eliminate the redundancy in the survey.

A weight attributed to each component based on social status, SWM and 'allotment garden' criteria, allowed the classification of the puroks according to their social profile.

5.2.1.1. Principal Component Analysis (PCA)

Traditionally the major objective of the PCA was to reduce an overly large data matrix. In our case, the answers to a social survey were the basis of our statistical methodology and needed to be summarized with the least loss of information possible. (For more information, cf. EVERITT, DUNN, 1991 and COX, 2005)

The PCA was first elaborated, by Pearson (1901) H. Hotelling (1933), followed by Anderson (1958). It is among the most widely used techniques in factor analysis. PCA is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. Since patterns in data can be hard to find in data of high dimensions, in which the luxury of graphical representation is not available, PCA is a powerful tool for investigating data. The other main advantage of PCA is that once a researcher has found these patterns in the data, it is possible to compress the data, i.e. by reducing the number of variables, without too much loss of information.

Using PCA has at least three objectives:

1) determining the correlation between the variables in order to reduce the number of variables;

2) obtaining non-correlated factors which may be used in different methods such as; regression, discriminate analysis;

3) visualizing observations in a 2 or 3 dimensions space, in order to identify homogeneous groups of observations or the opposite situation.

The real aim of PCA is to "reduce dimension to two or three while keeping as much information as to the inherent variability within the data" (COX, 2005).

Using PCA supposes that the user has a large matrix with variables in columns and individuals on whom the experience will be carried out in rows, and that the user wants to synthesize this information while ensuring the least loss of information possible. Even if the method can be applied to any data, there is no guarantee that the results will be meaningful and *th*e method remains a method of investigation.
Most of the usual applications are linked to biometry, economy and human geography. We want to determine which factors influence the socio-economic status, familial status or ethnic composition of our pilot zone.
The final output map, the Statistical map, classifies puroks according to SWM and social profile.

5.2.2. Spatial Index map

As the purpose of the spatial index map was to compute a spatial index from land uses classes in order to obtain urban landscape characteristics UA oriented, imagery from a high-resolution satellite image, Quickbird, was used on a three step method :
- land use classification;
- identification of built-up areas;
- identification of garden areas (THOMSON, HARDIN, 2000).

For this purpose, some conditions for the estimation are pre-required:

- detailed spatial resolution to allow the identification of individual structures even through tree cover, and to determine if the buildings are residential, commercial or industrial;
- estimate of the average number of persons per dwelling unit;
- assumptions that all dwelling units are occupied and only one family lives in each unit (FOX *et al*, 2004).

The objective of using a spatial indices methodology is to clearly identify zones, with some socio-morphological-landscape criteria. Rich and poor zones can be differentiated on the targeted zone. The reflection is based on the land use houses and gardens classes and on several indices.

Before any computation, in agreement with local NGO and communities' perspectives, three assumptions were made, bearing in mind that developing countries are the target of the study :

1) If "houses" patches (cf. Appendix 1) are large, it was assumed that rich people were living there. In this area, larger patches of the class of 'houses' are the sign of larger buildings. Larger buildings may represent villas or private zones. Squatter or poor zones have a very different spatial geometry. It is more an accumulation of small patches of 'houses'. Hofman and other scientists clearly illustrated the need to combine the shape of informal settlement with spectral information in his studies (HOFMAN *et al*, 2006) in order to identify informal settlement.

2) If "house" patches were mixed with 'garden' patches, it was assumed that this was a "rich" zone. The assumption is based on the idea that rich people have the possibility of owning a house and a garden, or even a park. The mix between the two classes was taken to represent a richer zone.

3) Some puroks have more opportunities for gardening as there are more 'agricultural' and 'garden' patches. As the current research is based on gardening, it was assumed that zones with more gardens provided more opportunity to own garden lots.

The first step in the calculation of the index was to carry out a classification of a remotely sensed image with a good spatial resolution.

The assumption underlying this approach is that any functions, different densities of residential development for instance, can be distinguished based on the spatial distribution and the land cover pattern. Puissant or Hofmann argued that informal settlement are so heterogeneous due to the area or to the shadow, that only new classifiers with a high spatial image are able to identify clearly these specific houses (PUISSANT *et al*, 2006 and HOFMANN, 2001).

Specific software (e-Cognition®), used in the case of high spatial resolution, was used to provide to an intelligent discrimination of objects. The software operates in two major ways: image segmentation and classification.

The basic idea of this type of software is that important semantic information necessary to interpret an image is not represented in single pixels, but in meaningful image objects and their mutual relationships (BAUER and STEINNOCHER, 2001). A segmentation technique is used to build up a hierarchical network of image objects; through segmentation, the contours of an object are detected through local transformations or criteria based on measures of local homogeneity. Hence, each image object "knows" its neighboring objects and it is possible to define relations between these objects.

5.2.2.1.Spatial metrics

The use of spatial metrics was introduced for extracting from the landscape, indicators of economic poverty based essentially on the form of houses and gardens.

Urban geography and urban modeling have been explored for a long time with the applications of Batty or Knox (1994). Nevertheless, an improvement of urban land use analysis seems possible using additional analysis or data.

Using structural and textural information from remote sensing data, land use classifications can be improved. The development of landscape metrics or indices is based on information theory measurements and fractal geometry (Appendix 2).

As explained in the introduction about remote sensing, spatial metrics based on patch-units represent a good means to analyze urban spatial structure that is too difficult to analyze due to the heterogeneity of the urbanization process. Landscape metrics represent quantitative measures of spatial structures and pattern. The analysis rests on different hypotheses about patch, landscape and class (cf. definitions below) characteristics that run along a landscape modification gradient, such as urban to rural in our situation. The use of spatial metrics is increasing in urban environments for linking '*land-cover heterogeneity to structures and dynamic changes in urban land uses*' (HEROLD *et al*, 2003).

One of the most important challenges in the context of using spatial metrics is the validation of the methodology on a small pilot area. Spatial metrics have been used to evaluate and assess the goodness of fit in terms of spatial structure and to highlight specific problems, uncertainties or limitations of the model results. The type and number of metrics used varies from study to study and different metrics have been found useful in describing different characteristics of model performances and results (HEROLD *et al*, 2005). Some authors have also proposed using spatial metrics on smaller areas and regionalizing metric analysis to an appropriate scale of analysis.

These types of indices "represent the spatial distribution and pattern within a landscape of a single patch type; whereas, landscape indices represent the spatial pattern of the entire landscape mosaic, considering all patch types simultaneously" (MCGARIGAL and MARKS, 1994).

The interpretation of the type of indices can be different according to class or landscape indices. The first can be interpreted as fragmentation indices "because they measure the fragmentation of a particular patch type; whereas, most of the landscape indices can be interpreted more broadly as landscape heterogeneity indices because they measure the overall landscape structure" (MCGARIGAL and MARKS, 1994).

Class indices may be interesting for the spatial situation of the current research. As the zone may be divided into subzones, they may be spatially-morphologically classified thanks to class and landscape indices. For example, it may be possible to know the quantity of patch 'houses' or 'gardens' in the different subzones or quarters.

The analysis was applied on the high-resolution image classification. The principal spatial metrics, which were computed, were used in an analysis produced by Herold (HEROLD *et al*, 2003). See appendix 2 for detailed formula of Mean Shape Index used.

5.2.3. Output Statistical Spatial Index map

The Statistical Spatial Index map is a weighted combination of the Statistical map and the Spatial Index map.

Statistical Spatial Index map = α * Statistical map + β * Spatial Index map

5.3. Profitability Survey approach (PS)

The purpose of the Profitability Survey map was to select the best plot from the UA point of view according to the profitability criteria.

This last map focuses on variables related to economical profitability or profitability for the communities and planners. The objective of this noncompulsory step was to give another class of priority to the pre-selected plots by ESC or SSI methodology.

The creation of the map is based on a survey conducted in the targeted communities selected around adequate plots.

All results from the survey were implemented into a specific equation based on the rent and profit equations:

According to GARDNER and RAUSSER (2001) the two following classical equations are widely used in the economical environment:

Rent equation :

$$R=Q*(V-P)-Q*d*c$$

Q= quantity produced
V= selling price
P= production Cost
d= distance between production place and selling place

c= transport cost
R= rent

<u>Profit equation:</u>

Л= P*Q(L) – P_L*(D)*L – c D

Л= profit
P= price of goods produced
Q= quantity produced
L= amount of land used
D= distance from market
P_{L}= price of land per acre per year
c= cost of transportation per mile per year

We decided to adapt this philosophy of research in economics to our specific context turning it into a Profitability mechanism. Each variable was coded from 0.01 to 1 according to its positive or negative connotation as perceived by community in UA and SWM. On this basis a Profitability Survey (PS) model has been established by subtracting a profitability cost (PC) from production value (PV):

PS= PV-PS

Production value (PV): Combination of peoples' skills, production orientation, plots' use, plots' potential and income variables:
PV= Skills*Production orientation*plots' use*plots' potential*income

Production cost (PC): Combination of plots' threats, fertilizers, transportation mean and accessibility variables:
PC= plots' threats*fertilizers*transportation mean*accessibility

Sampling methodology was implemented for surveying and collecting the needed data. Plots pre-selected by one of the approaches, ESC or SSI, constituted the starting point of the survey. A member of each household who is the most motivated for UA within a certain radius from plots was interviewed; a minimum of 30 households for all the plots is necessary in order to have a significant statistical sample (BÉGUIN, 1979). Ideally, city administrators will participate in the survey.

The selected people only had to answer all questions (cf. Appendix 9a) related to the plot for which they have been selected. If they belonged to the intersection of two plots (established with the radius chosen at the beginning of the interview) or more, they had to answer questions related to use of the plot, means of transport and potential of the plot, two or more times. It was compulsory that the representatives of farmers who were cultivating the project's pilot plot were part of the selection. The city administrator only answered the last question.

From an accessibility point of view, different weights were attributed to buffers starting from roads and markets with a pre-defined distance established by the communities. This distance was based on the daily walking distance that members of the household were prepared to walk between markets and roads near their homes. Values of weights decreased from the central point of the buffer.

5.3.1. Profitability

Holmer et al (2001 (b)) have drawn a conceptual framework of socio-economic interactions of periurban vegetation production, marketing and consumption in the Southeast Asian countries. Figure 5.2 illustrates the needs of an 'economical' step in the general process of the current research. The surveys, both social and economical, were conducted to evaluate the consumption practices, the marketing systems and the vegetable farming practices for the economical survey, and the social factors for the social survey.

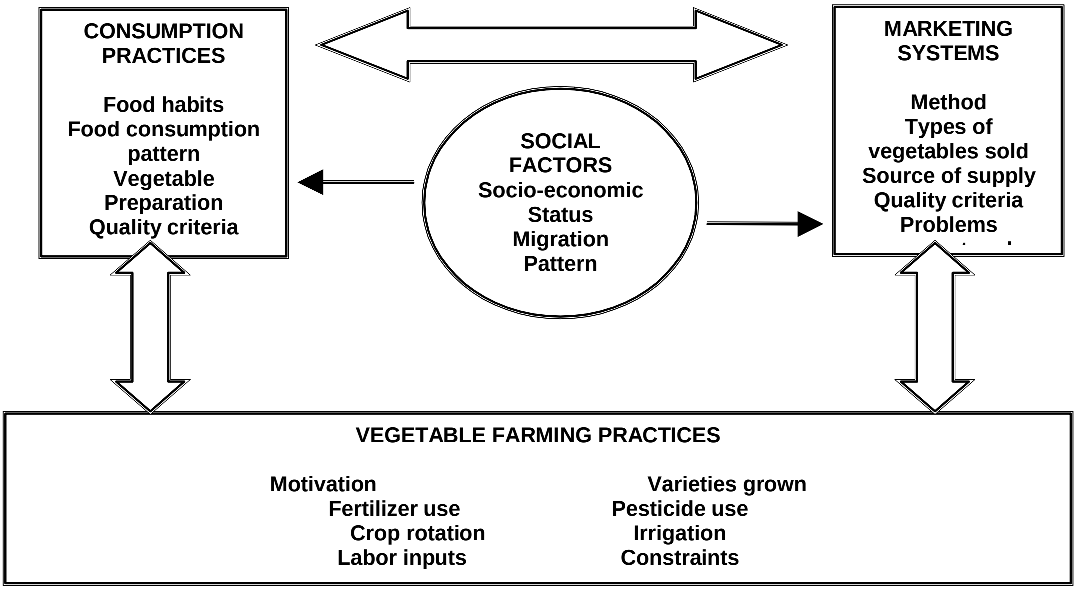

Figure 5.2: Socio-economic interactions of periurban vegetable production, marketing and consumption in South-East Asia (Inspired from HOLMER *et al*, UA, 2001)

(For a complete description see HOLMER et al, 2001)

Since the actual type of agriculture as exportation oriented does not answer the needs of local communities in the developing world, a focus on the local economical profitability of an UA plot must be performed.

The objective was to elaborate a new type of agriculture with these characteristics:
- a growing environmental regulation of agriculture;
- a creation of a more sustainable agricultural system;
- production of food within an increasingly competitive and liberalized international market.

In production theory, the focus is on three essential questions:

- what to produce ?
- how to produce it ?
- how much to produce ?

Before proposing a development plan to the regional planners, economic information must be added to the social and physical information.

Before implementing the production of any product, a list of factors that may influence the supply of the agricultural product must be established:

- the price of the product;
- the price of competing products;
- the price of joint products;
- the price of inputs;
- the state of technology;
- the material environment;
- the institutional setting.

Since the beginning of the analysis production functions, researchers clearly established that agricultural output is a function of quantities of labor, land and capital used.

The final objective of the Profitability Survey map is to clearly compute the direct benefits of any production vegetable (or others) on selected plots through a Profitability analysis. The direct benefits were based on a market distance, made with a given production, selling price, production cost and transport cost (cf. Appendix 3).

Chapter 6. Data gathering and analysis

It seems that even data is difficult to obtain in developing it allows the performing of appropriate analysis for helping to solve development problem. However, as most scientists have some reservation about the reliability of statistics coming from such countries, doubts about the reliability of data should have repercussions on the analysis results. All the outputs and inputs must be validated before any process can be carried out (NAUDET, 1999; BEAUCHEMIN, 2002). The general methodology is applied in the context of a city, Bacolod, in a developing country, the Philippines. Due to difficult access to data or lack of data, the equations of the general method are nuanced in relation with the context.

The two approaches (cf. 5.1 and 5.2) have been tested on Bacolod City-Barangay 7 pilot site: ESC and SSI. The potential of an additional technique, a Profitability Survey (PS) has also been analyzed.

6.1. Environment Social Community approach (ESC)

As the current research is a quadripartite project, each partner (City, Community, NGO and specialists) was willing to share data, which may be used in the approach.

6.1.1. Data gathering for the ESC approach

Data from City source	Details	use
Roads	Date of acquisition: 01/2003 Covered area: Bacolod Attributes: length, name, class (minor, major, eskinitas[1]) Projected coordinate system name: Philippines_Zone_IV Geographic coordinate system name: GCS_Luzon_1911 Geometry type: line	Accessibility map (3km buffer map) (Barangay 7)

[1] Eskinitas : local word for shortcut

Rivers and creeks	Date of acquisition: 01/2003 Covered area: Barangay 7 Attributes: elevation, thickness Projected coordinate system name: Philippines_Zone_IV Geographic coordinate system name: GCS_Luzon_1911 Geometry type: line	Accessibility map (estimation to accessibility to water) (Barangay 7)
Hazard areas	Date of acquisition: 01/2003 Covered area: Bacolod Attributes: type (flood prone areas), location, perimeter Projected coordinate system name: Philippines_Zone_IV Geographic coordinate system name: GCS_Luzon_1911 Geometry type: Polygon	Accessibility map (estimation to the location of flood prone areas) (Barangay 7)
Barangay boundaries	Date of acquisition: 01/2003 Covered area: Bacolod Attributes: land use code, location, population, income, density Projected coordinate system name: Philippines_Zone_IV Geographic coordinate system name: GCS_Luzon_1911 Geometry type: Polygon	All maps (geographical coordinates) (Barangay 7)
Markets	Date of acquisition: 01/2003 Covered area: Bacolod Attributes: label Projected coordinate system name: Philippines_Zone_IV Geographic coordinate system name: GCS_Luzon_1911 Geometry type: Point	Accessibility map (estimation of the nearest market) (Barangay 7)
Socio-economic profile	Date of acquisition: 2005 Area covered: Bacolod-City (for more information, cf. Appendix 4)	Social map (Barangay 7) (Computation of the SBI in order to evaluate the social status of the Barangay)

Table 6.1: Data from city source for the ESC approach

Data from NGO/Community source	Details	Use
Community maps	Creation: 27/03/2003 Validation: 9/04/2003	Community-based map (Computation of the DII based on Social Services Infrastructure, SWM, Economical features and allotment garden features) (Barangay 7)
Social Survey (cf. Appendixes 5a & 5b)	Date of acquisition: 2003 Information about households, food/nutrition, income, jobs, health, agricultural uses, housing characteristic and community resources	Social map (Barangay 7) (Computation of the SBI in order to evaluate the social status and the motivation and the knwoledge about SWM and UA of the Barangay)

Table 6.2: Data from NGO/communities sources for the ESC approach

Data from external source	Details	Use
Remote sensing image (Appendix 6)	Area: Bacolod, Philippines Collection date: 10/10/03-28/10/03 Sensor: Quickbird 2002 NW Corner: 10.7029, 122.926 SE Corner: 10.6141, 123.023 Product type: Standard 2A (Bundle) Resolution: Multispectral, 2.44-2.88 meter; Panchromatic, 61-72 cm	Land Use map (Barangay 7)

Table 6.3: Data from external source for the ESC approach

6.1.2. ESC approach chart

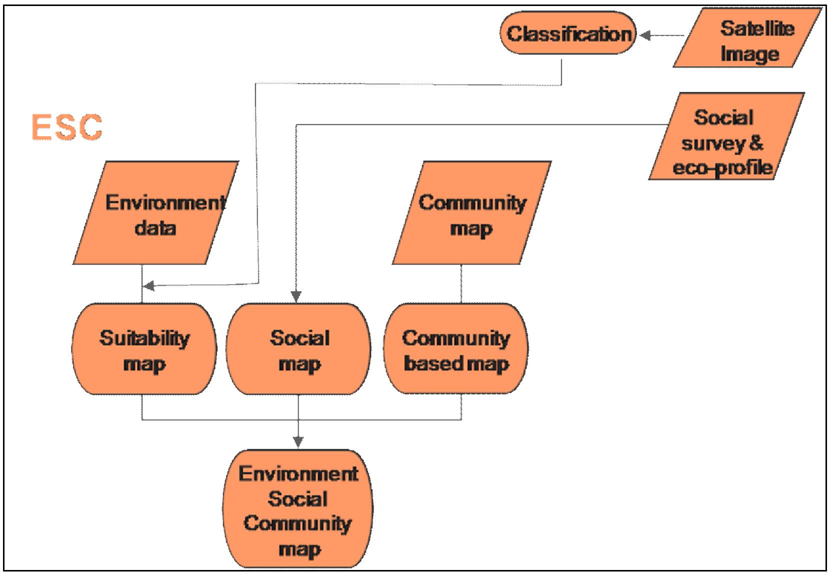

Figure 6.1: Chart of the Environment Survey Community approach

6.1.3. Suitability map

The first step in the ESC methodology was the building of a suitability map on UA by combining accessibility, land use and water variables.

6.1.3.1. Postulates

Before any manipulations can be performed, some basic postulates have to be put forward, without any empirical basis :

- Walking distance: urban Filipinos seem to prefer to take jeepneys (ameliorated jeeps used as a common taxi) rather than walk. So, the maximum walking distance for one day has been fixed at 3 km. This is the optimized distance in order to not waste time and that takes into account the situation of mothers who must also take care of their children.
- Farmers may cultivate fields outside their puroks (HOLMER et al, 2003).

6.1.3.2. Accessibility

In the general methodology, the three elements of creeks, markets and houses were integrated into a GIS as these are the crucial elements for the implementation of the urban garden (PUVeP, 2008). In this specific case, there was no sense in doing this because :
- the creeks belong to another barangay;
- every market is used independently of the distance;
- no cadastral plots are available and there is too short a distance between houses.

As seen on the map, only access to eskinitas was computed. Eskinitas are a synonym for a shortcut and facilitate access to all elements of any barangay. They are not made in durable materials and therefore may be unusable during flood periods. Filipinos frequently use shortcuts because main roads are too general and do not provide access to houses or main elements such as the Barangay Hall.

Therefore, accessibility is calculated on the location of wells and eskinitas. However, in this case the wells are located in the eskinitas therefore accessibility is only a function of the eskinitas. Accessibility was analyzed by the way of 3km buffer map around eskinitas or pathways :

accessibility map = *eskinitas buffer*

It is very important to compute accessibility in the case of perishable and highly value added vegetables such as those, which could be produced in Barangay 7.

Concerning the maximum distance that local people have to walk from a road until the limit of Barangay 7, the result is 252m. The accessibility of Barangay 7 is therefore adequate for the way of life of the inhabitants. As 3km is the maximum effective walking distance (cf. 6.1.3.1).

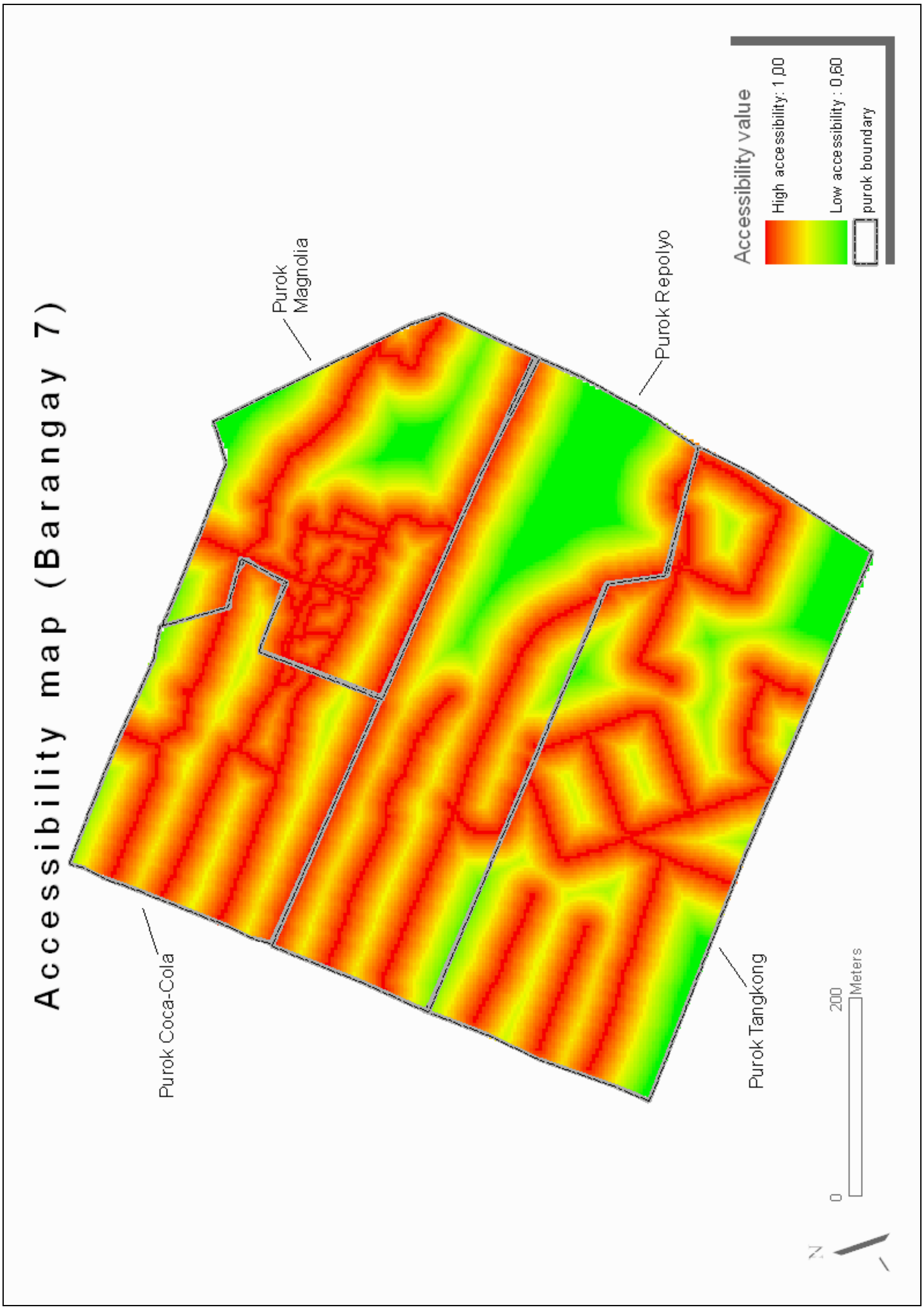

Figure 6.2: Accessibility map (Barangay 7)

Repolyo seems to be the least accessible (green color in the west part). This is essentially due to the presence of more open spaces located inside the purok. Magnolia is well served due to the compulsory access to Barangay Hall, a key element in the community's daily life.

In a barangay, wells are also crucial elements, and in UA, without access to water, gardening is impossible. In the case of Barangay 7, all the wells are located near eskinitas. Therefore, only eskinitas are used for the accessibility analysis.

A plot located near an eskinitas or in the proximity of a red zone offers more opportunities for farmers.

6.1.3.3. Land

The land variable is derived from a land use classification. A high spatial resolution satellite, like Quickbird, seems to be one of the most suitable satellites for this particular step of land use classification (cf. Appendix 6 for more details about Quickbird Satellite).

The methodology used for the classification was a nearest neighbor classification process with class-related features. The whole classification system in the software used, was based on fuzzy logic. The class description of each class was the key editor for the knowledge base.

In order to obtain an accurate land use, at least urban areas and gardens were identified.

Since the information contained in the image is so rich, the classification was as follows :

1. Light roofs
2. No data
3. Land cover
    1. Others
        1. Roads
        2. Water
    2. Vegetation
        1. Gardens
        2. Trees
        3. Agricultural parcels
    3. Urban
        1. Other roofs

Figure 6.3: Classification classes

The distinction between all the classes and sub-classes is dependent on various criteria such as:
Brightness: (e.g.) to make a distinction between roofs and some agricultural plots;
Area of the object: example: to make a distinction between gardens and agricultural plots;
Length of the object: example: to classify roads;
Length/width: example to classify roads;
Spectral mean (Infra-Red): example: to make a distinction between houses and garden.
The membership function of the software facilitates the distinction.

The knowledge of Balayan and a field trip were used for training the supervised classification through the definition of training sets.

In the thematic classes, a difference between roofs and light roofs exists, as it is visible on the image. Some roofs appear to be very "blank", and the spectral response is very different, so, two classes were adopted, in order to have more facilities in the threshold decision of the membership function. However, both were included in the 'house' class.
Seven classes were represented in the classification: houses, agriculture, gardens, trees, water, roads and no data.

With those specifications, the overall accuracy of the classification was determined to be 76%. The general KIA or Kappa was 0.72 (agreement between reference classification (ground truth) and classification itself) (cf. Appendix 7: Confusion matrix).

This mean accuracy may be understood as the user accuracy and producer accuracy. With regards to the production precision, the classes 'roads' and 'other roofs' seem to be problematic. The user precision is quite good for all the classes except for the class 'trees'. In this case, pixels have been classified as gardens, due to the similarity of the spectral response or as other roofs. Nevertheless, some pixels (0.1%) remain unclassified (cf. 5.1.1.2).

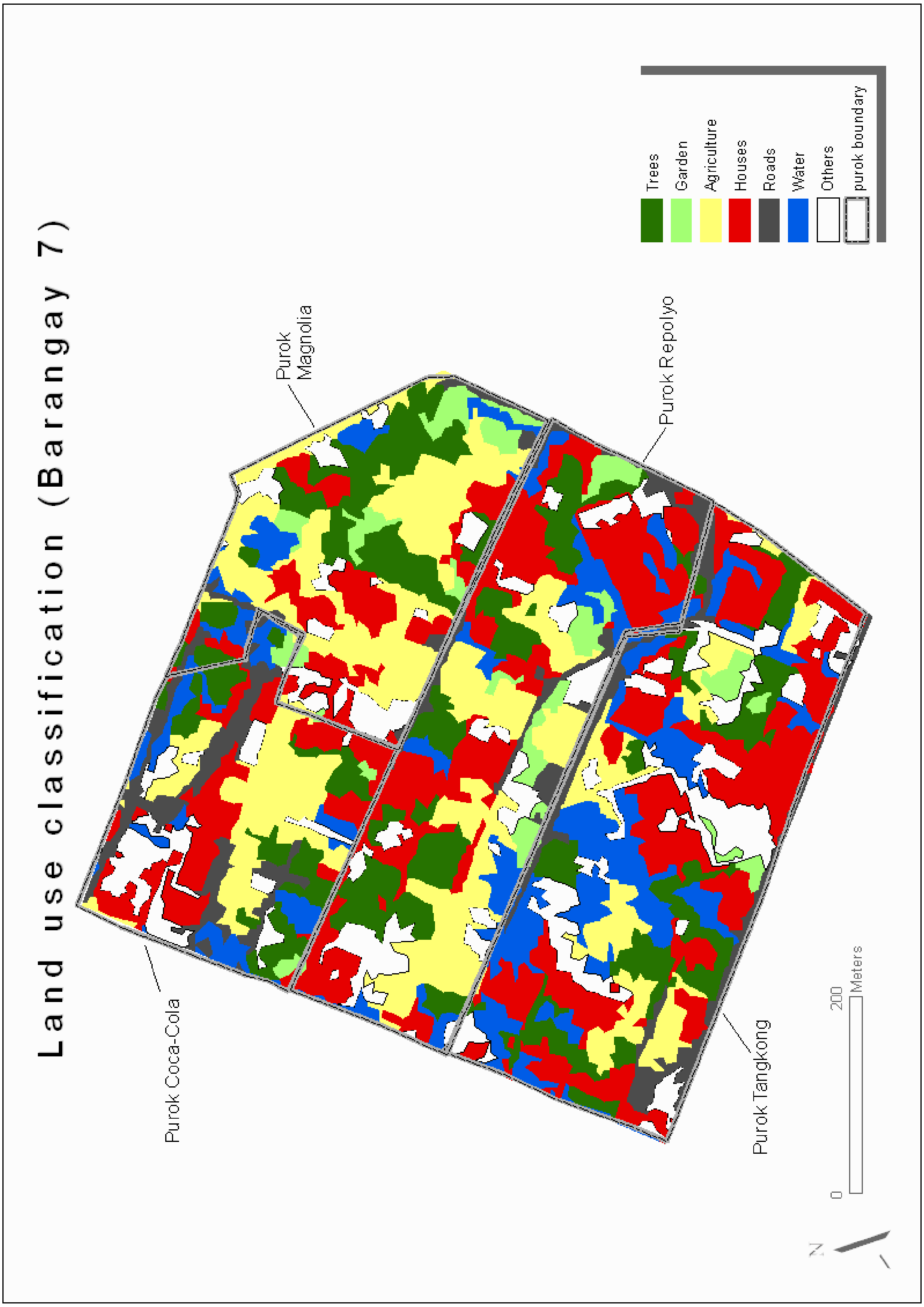

Figure 6.4: Land use classification map (Barangay 7)

Due to the specific urban location of Barangay 7, the presence of heterogeneous pixels may be important and the results of the classification may be affected by this current phenomenon in urban zones and with high-resolution image.

Additional pictures and field trips have allowed the validation of outputs, but in some zones, difficulties were encountered due to the socio-political context. Therefore, some areas were not accurately spatially validated (0.2%).

These two problems may distort the overall accuracy of the classification.
As the land use given by the City Office of Bacolod was quite old dating from 2001, the remote sensing classification dating from 2004 was considered as the land use reference for validation.

The land map was drawn up thanks to a reclassification of a raster composed of the land use classes: trees, gardens, agriculture, houses, roads, water and ‘others’. In Barangay 7, roads and water were totally excluded from the process of UA. It is not possible to cultivate in these zones, therefore they were represented by a mask. Other classes were taken into account with weights from 1 for ‘other’ to 10 for gardens. Houses were given the mean weight of 5 as it is possible to cultivate on a house plot but on a small area.

For soil, slope, flood prone areas and plot size, the situation was specific in our case :
soil type: there is only one soil type for the whole of Barangay 7;
slope: the degree of slope is too flat and the same for the entire barangay;
flood prone areas: there is no flood prone area inside the barangay;
plots size: there is no cadastre available for the barangay.

Land use classes have been given values according priority to pixels classified as gardens or agricultural plots since it was assumed that those zones are the most suitable for allotment gardening, at the opposite of water or industrial zones. With the members of Balayan, houses and tress are accepted since it is possible to garden even a plant of tomato just besides a house or a tree. It is also possible to collect fruits from the trees.

Land use type	Values
Gardens	10
Agricultural plots	10
Houses	5
Trees	10
Water	0
Others	1

Table 6.4: Land use types and values

Land map = landuse (10 * trees+10 * garden+10 * agriculture+5 * houses+ others)*mask (roads, water)

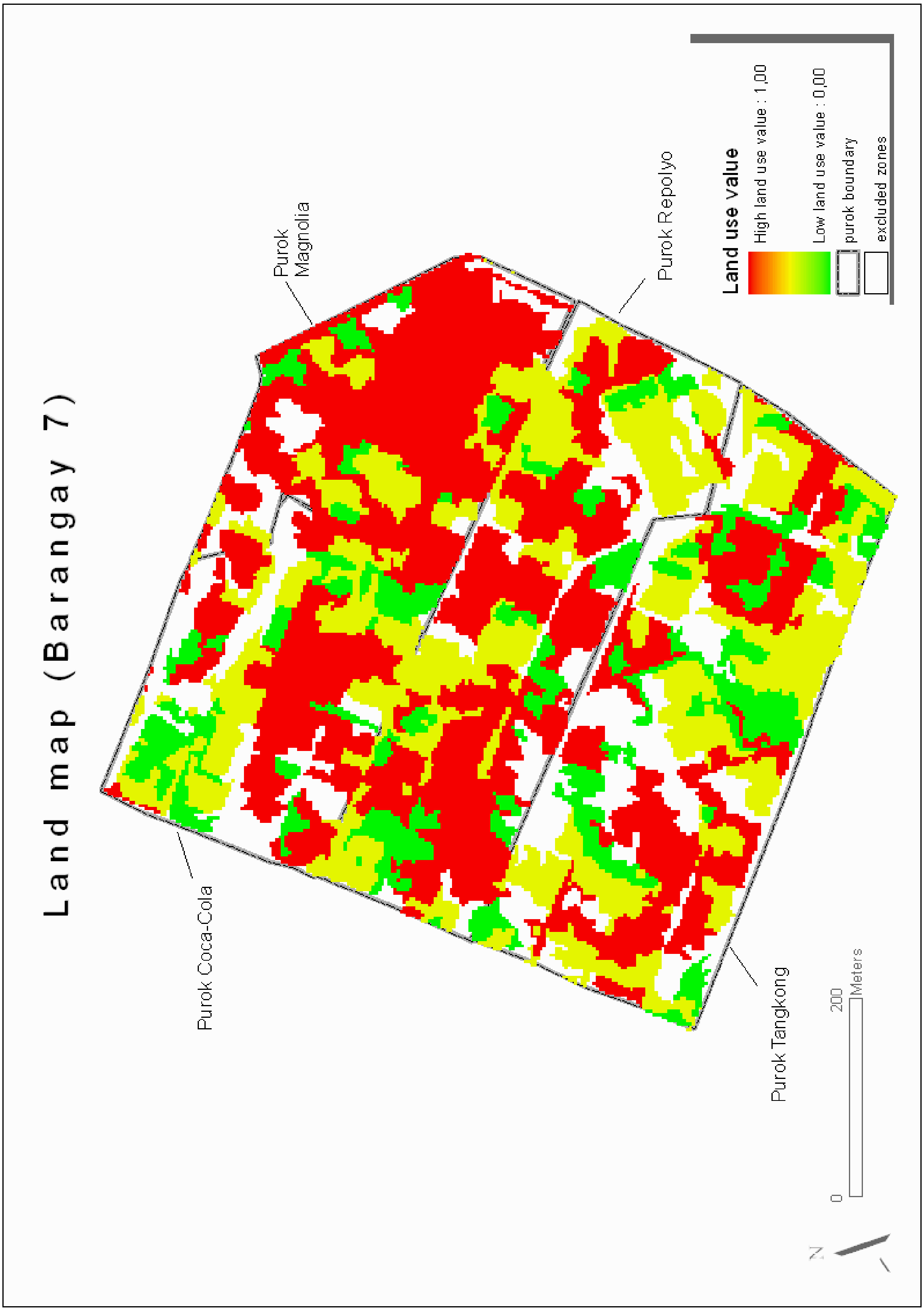

Figure 6.5: Land map (Barangay 7)

In the purok Magnolia, due to large patches of agricultural classes, values of land use were high. Repolyo also offered good opportunities for gardening in terms of land use due to agricultural and garden patches. Tangkong had many large patches of houses giving lower values to the land map inside the purok. White zones represent water zones and roads, which have been excluded from the process of land use value attribution. UA is possible along the roads but not on the roads.

6.1.3.4. Water

In the case of Barangay 7, no data about water quantity or quality was available and creeks are outside the pilot zone. Therefore, water was not taken into account.

6.1.3.5. Output: Suitability map

The suitability map was computed from the accessibility and land use information. Parameters gave same importance to each effective component of the suitability map:

Suitability index = 0.5 * accessibility + 0.5 * land + 0 * water

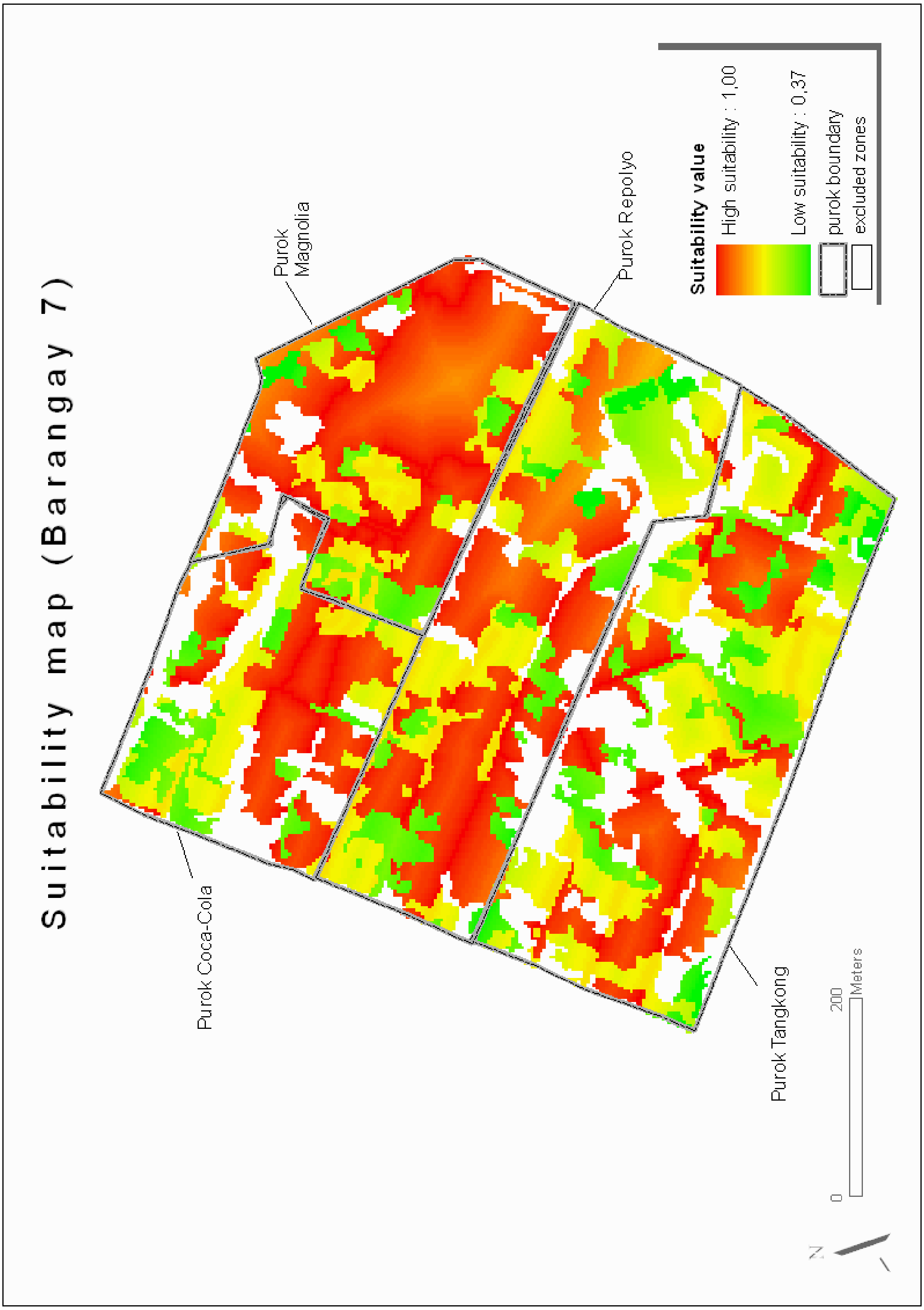

Figure 6.6: Suitability map (Barangay 7)

As accessibility and land use have the same weight in the suitability equation, no more importance was given to accessibility than was given to land use. However, weights on the different classes of land use prioritize some specific classes such as agriculture or gardens.

Due to the presence of many eskinitas in the puroks in the North of the Barangay 7, Coca-Cola and Magnolia obtained a good index of accessibility and therefore suitability. This index was calculated based on the mean of each object coming from the suitability map. In fact, as the land map was based on an object-oriented classification, it was difficult to precisely analyze each purok since patches often belongs to one or more than one purok.

The map presents a range of values from 0.37 to 1. The highest and therefore best zones in terms of accessibility, are essentially located along the roads or the eskinitas. In the eastern part of purok Repolyo, an important spot obtains a negative value due to the presence of open spaces without roads in this part of the Barangay. In the corner at the south-south-east of the purok, a large house patch gives low values since a chapel, without any suitability value, occupies this zone.

The purok Magnolia has a large suitable area regards urban agriculture due to the presence of adequate land uses, such as agricultural areas but, this large spot is affected (an orange color in the middle of the zone) by the addition of accessibility information. This large zone of adequate suitability was also due to the combination of small patches of other land types. In this case, diversity of land type brought suitability. With few exceptions, garden and trees were located side by side and since they have the same land use weight, patches with suitable zones cover larger zones.

Finally, Tangkong is the last priority purok for UA from a suitability point of view due to the presence of large land holdings; there are very few patches of houses but those that do exist are very large.

6.1.4. Social map

This second map is based on the social characteristics of Barangay 7, where in collaboration with Balayan (local NGO), a social survey was conducted which had the major objective of evaluating the social composition of the Barangay (cf. Appendixes 5a and 5b).

6.1.4.1. Survey-Based Indicator (SBI)

Discussions were carried out with Asia Urbs' project team (cf. Chapter 5, Introduction) and with the members of the Balayan NGO resulting in the elaboration of a global equation for the SBI index combining income, people density, awareness for garbage segregation benefits, garbage practices and skills for UA.

Many other variables are present in the Social Survey of the Barangay and in the Socio-Economic profile of Bacolod, but it seems that SBI summarizes well the social composition of the Barangay as far as UA is concerned.

Each of the elements of the SBI equation was discussed with the FGD[1] of Barangay 7 and with members of Balayan. Weights were attributed to all of them. The maximum value was 10 and the lowest was 0.001 instead of 0 for computation facilities.

1) Income*people density values

This Income*people density index was computed through the integration of data coming from the Socio-economical profile of Bacolod City.

The targeted communities are the poorest with the highest population density. Poverty was established in comparison with the national poverty index of the Philippines. Based on this index, people with an income lower than 5000PPH/month were considered as poor. A density higher or equal to 178.2 inh/km² was considered as high, as this is the mean density for the Philippines between 191 and 2005, and is higher than the world mean people density, which is 42 (WORLD BANK, 2000).

Level of Richness	Level of density	Income*People Density value
Rich	Low	1
Rich	High	3
Rich on average	Low	5
Rich on average	High	7
Poor	Low	8
Poor	High	10

Table 6.5: Income density characteristics

The Income Density in Magnolia, was the lowest due to the high income even if the density of population is one of the highest compared with the density of Coca-Cola. Tangkong was the target community with the lowest monthly income and a mean density of population.

Purok	Income (PPH/month)	People Density (inh/km²)	Income* People Density.
Magnolia	8175	181	3
	Rich	High	
Coca-Cola	6061	165	7
	Rich on average	High	
Repolyo	5083	25	8

1 Focus Group Discussion is a method of discussion where all opinions are listened; in our case, the group is composed of leaders from the Barangay 7 (Ly, 2001)

	Poor	Low	
Tangkong	4428	48	9
	Very poor	mean	

Table 6.6: Income*People Density per purok in the Barangay 7

2) Awareness for Garbage Segregation

Awareness was calculated simply as "possible"; if people were aware of the importance of garbage segregation they were allocated a value of 1; maximum lack of awareness was set at 0.001. Considering that space is a stressing variable in the majority of developing countries, segregation is vital. Moreover, waste segregation offers many jobs to communities, such as garbage collectors, trucks drivers, etc. As the objective of the methodology was to select people motivated for UA, some awareness about composting is also taken into account in the awareness variable.

In Barangay 7, none of the puroks was aware of the benefits of garbage segregation or of general SWM. All the puroks were therefore given the lowest value of 0.001[1]. Even though Barangay 7 was involved in many projects of SWM, people are not aware of the benefits of their waste segregation.

According to some researchers such as Reiss or Lim (GUANZON, HOLMER, nd),education may influence knowledge but also people's open-mindedness about innovation but, at the opposite end of the spectrum, some authors point out that education is not a necessary condition to be aware of the working environment.

3) Skills for UA

It was assumed, with the help of the FGD from Barangay 7, that people's skills about agriculture partly come from their current or former jobs. Therefore, 'skills' were calculated in terms of their major source of income which is normally their jobs. The FGD assumes, for example, that a vendor or a cook had various skills in many domains such as agriculture thus his/her value of skills was 10, comparatively a driver obtains a value of 1.

The FGD identified six major classes of jobs; other sources of income exist in the barangay but are not common (manicurist, cashier, etc.) and are not representative.

Class of jobs	Skills about UA value
Drivers (pedecab, taxi, jeepney…)	1

1 The value is 0.001, not 0, due to the further calculation, in order to avoid a global value of 0 for the all equation

Vending (sari-sari[1], eating…)	10
Employee (office, government…)	1
Laundry	7
Cooking	10
Construction worker	2

Table 6.7: Skills value and jobs classes

For each class of jobs, puroks were given a skills value by multiplying the percentage of job's types present in the purok by a weight. The final result is the mean of each weighted job per purok.

Puroks	Class of jobs	Occupation (%)	Weight	Skills
Magnolia	Driver	29.17	1	0.29
	Business/Vending/Buy and Sell	31.25	10	3.12
	Employee	31.25	1	0.31
	Laundry	2.08	7	0.14
	Cooking	6.25	10	0.62
	Construction Worker/Carpenter	0	2	0
			Weighted Arithmetic Mean	0.7
Coca-Cola	Driver	27.03	1	0.27
	Business/Vending/Buy and sell	10.81	10	1.08
	Employee	37.84	1	0.38
	Laundry	2.7	7	0.19
	Cooking	8.11	10	0.81

[1] Sarisari", is a Filipino term which means "various kinds". The concept of the sarisari store is the same as other establishments but with no speciality at all. The store is equipped with a long list of commodities that can be bought in units rather than the whole package. Sarisari stores are present all over the Philippines. Most of these stores are owned and operated by private individuals and commonly built near or within the owner's home. The goods that include candies, canned products, biscuits, cigarettes and others, are displayed in a large covered screen or metal barred window. Benches are also provided in front of the store (http://www.sarisari-store.com/about_us.html)

	Construction Worker/Carpenter	13.51	2	0.27
			Weighted Arithmetic Mean	0.5
Repolyo	Driver	42.86	1	0.43
	Business/Vending/Buy and Sell	28.57	10	2.86
	Employee	28.57	1	0.28
	Laundry	0	7	0
	Cooking	0	10	0
	Construction Worker/Carpenter	0	2	0
			Weighted Arithmetic Mean	0.6
Tangkong	Driver	16.67	1	0.17
	Business/Vending/Buy and Sell	45.83	10	4.58
	Employee	12.5	1	0.12
	Laundry	0	7	0
	Cooking	0	10	0
	Construction Worker/Carpenter	25	2	0.5
			Weighted Arithmetic Mean	0.9

Table 6.8: Skills results

In Magnolia, there are many drivers and employees but both jobs obtain a low weight since the FGD estimates that their knowledge about UA and SWM was very poor. Nevertheless, Magnolia had a high important skills value due to their strong desire to work. In addition, Tangkong was regarded as highly skilled due to the strong presence of vendors.

A high rate of employees was also present in Coca-Cola due probably to the fact that in the two other puroks, there are opportunities for other types of jobs such as vendor in sari-sari. Coca-cola and Repolyo obtained a mean skills value due to the low percentage of high weighted occupations.

4) Garbage practices

Communities in the barangays employ many garbage practices, five alone in Barangay 7. Some are very environmentally-friendly, while others are totally incompatible with a clean environment. Segregation of garbage is the best practice for compost making, thus the Garbage Practice is 1.

Practices	Garbage Practice value
Segregation (eco-centre)	10
Compost	10
Burning	2
Burying	4
Throw away	1

Table 6.9: Garbage practices values

People in Magnolia seem to have been very conscious of the utility of segregation according to the results presented in table 5.8. When the staff of Balayan asked them if they segregate at home, 56% answered 'yes', as opposed to 91.6% answering 'no' in purok Repolyo. Coca-Cola obtains a value two times lower than Magnolia, which is the highest in terms of GP values. Globally, people are motivated to segregate but they are not aware of the benefits of this practice.

People in Magnolia were very motivated as it is the target of the Ecological Solid Waste Management Program supported by USLS, FUNDP-FUCID and the City Government of Bacolod. It is probable that the garbage station located in the purok motivates the communities.

It seems that belonging to an organization is a source of motivation for communities.
Garbage practice value = Σ (% of people practicing this segregation type in the purok * weight) / number of segregation type per purok

Puroks n=households	Ways of segregation)	%	Weight	Garbage Practice values
Magnolia (n=64)	garbage and segregation: burning, burying, throwing away	0.2	1	0.20
	garbage and segregation: compost, recycle, eco-centre	0.57	10	5.74
	sell	0.22	2	0.44

	Weighted Arithmetic Mean			2.13
Coca-Cola (n=49)	garbage and segregation: burning, burying, throwing away	0.34	1	0.34
	garbage and segregation: compost, recycle, eco-centre	0.45	10	4.53
	sell	0.21	2	0.42
	Weighted Arithmetic Mean			1,76
Repolyo (n=12)	garbage and segregation: burning, burying, throwing away	0.29	1	0.29
	garbage and segregation: compost, recycle, eco-centre	0.71	10	7.08
	sell	0	2	0
	Weighted Arithmetic Mean			2.46
Tangkong (n=28)	garbage and segregation: burning, burying, throwing away	0.18	1	0.18
	garbage and segregation: compost, recycle, eco-centre	0.79	10	7.88
	sell	0.03	2	0.07
	Weighted Arithmetic Mean			2.71

Table 6.10: Garbage practices results

5) SBI computation

Puroks obtained these SBI values by combining:

SBI value = Income*people density + Awareness*skills + Garbage Practice

Puroks	Income-People Density.	Awareness about UA & SWM	Skills about UA	Awareness* Skills (normalized between 1 to 10)	Garbage Practice	SBI
Magnolia	3	0.001	0.7	7	3	13
Coca-Cola	7	0.001	0.5	5	2	14
Repolyo	8	0.001	0.6	6	7	21
Tangkong	9	0.001	0.9	9	9	27

Table 6.11: Survey-Based Indicator results

Data from the social survey were available only per purok and so required a per purok Social map.

The social survey mapped by classical standardization showed that the communities from Tangkong were the social target of the research, followed by Repolyo, Coca-Cola and lastly by Magnolia. The results obtained from Tangkong are linked to its high values for skills and Income-People Density. Magnolia is in last place due to his low values in the estimation of poverty which means that, as highest in terms of richness, it will not be given priority in this research for a social perspective. In the context of our project, Magnolia fulfils the ‘environmental’ conditions, but this purok is the richest of the four puroks and is rejected given the declared priority of this research.

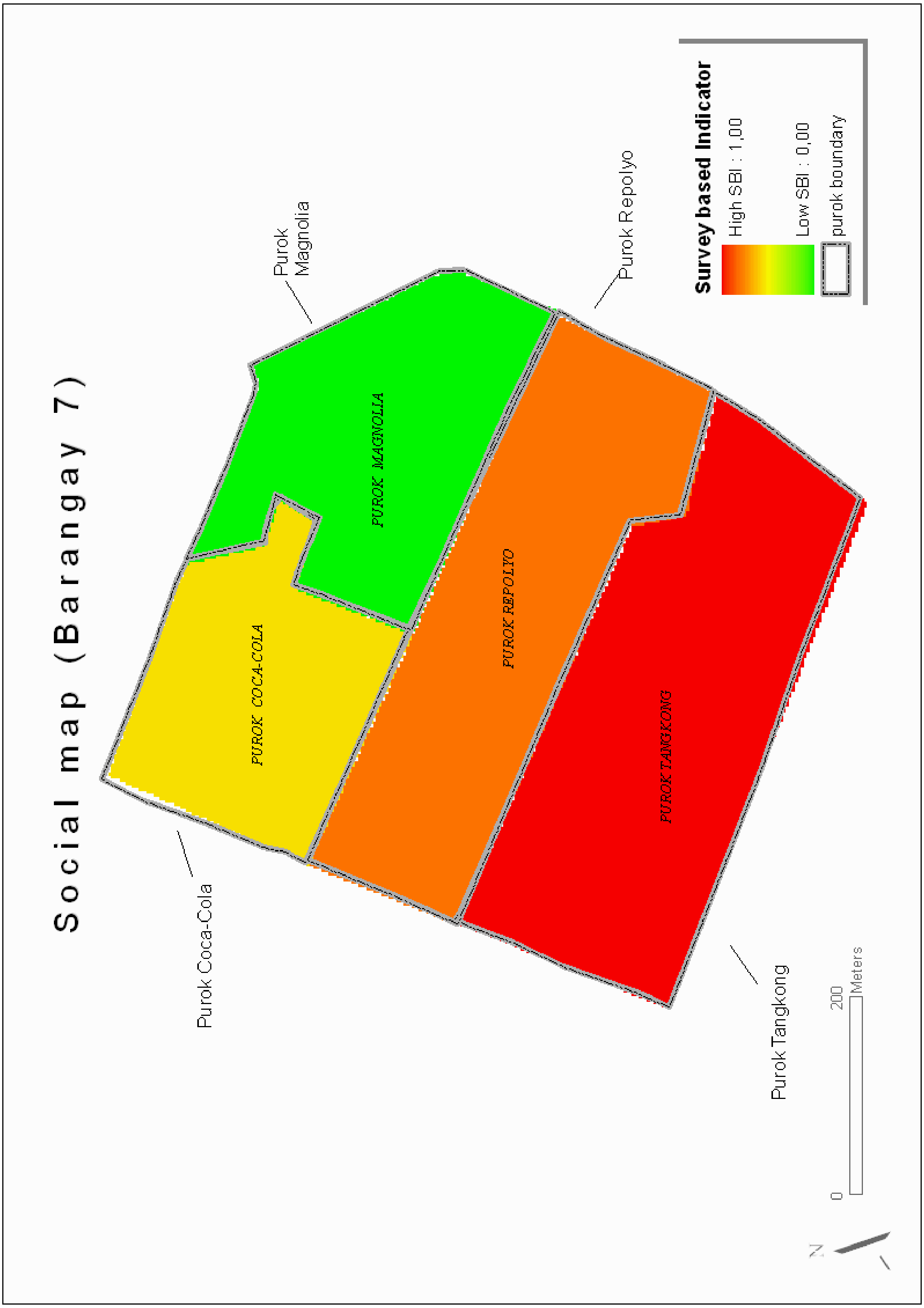

Figure 6.7: Social map (Barangay 7)

6.1.5. Community-based map

The community map is a source of non-scientific data aimed at determining the community needs and perspectives about elements of their daily life. People were free to draw any points of their own interest; they were the one conducting the activity to ensure the participation side of the methodology.

6.1.5.1. Community map

In the context of this research, the research institute, Environmental Science for Social Change[1] performed the community mapping by the way of training Balayan members who conducted the activity of community mapping, one community map per purok. The "community mapping" approach gave a process for dialogue and discussion, which is vital in establishing the socio-cultural context conducive for carrying out sustainable resource management. For 20 years, the ESSC has been involved in community resource mapping for forestry management. Their approaches have been applied to our urban context with the creation of several seminars for scientists and local communities.

With the ESSC's help, Balayan has been trained in community mapping activity.
On the community map, the communities were expected to dram whatever they wanted to show the city and not what the NGO expected them to draw. They drew the features on four different plastic slides: social-services, SWM, economic and allotment garden.
Each element of the 4 domains have been digitized (Figure 6.9).

The community map is summarized in the DII by a weighted combination of social-service infrastructures features, SWM features, economic features and allotment garden features.

[1] "ESSC is a Jesuit research institute that promotes environmental sustainability and social justice through the integration of scientific methodologies and social processes" (http://essc.org.ph/content/blogcategory/22/38/)

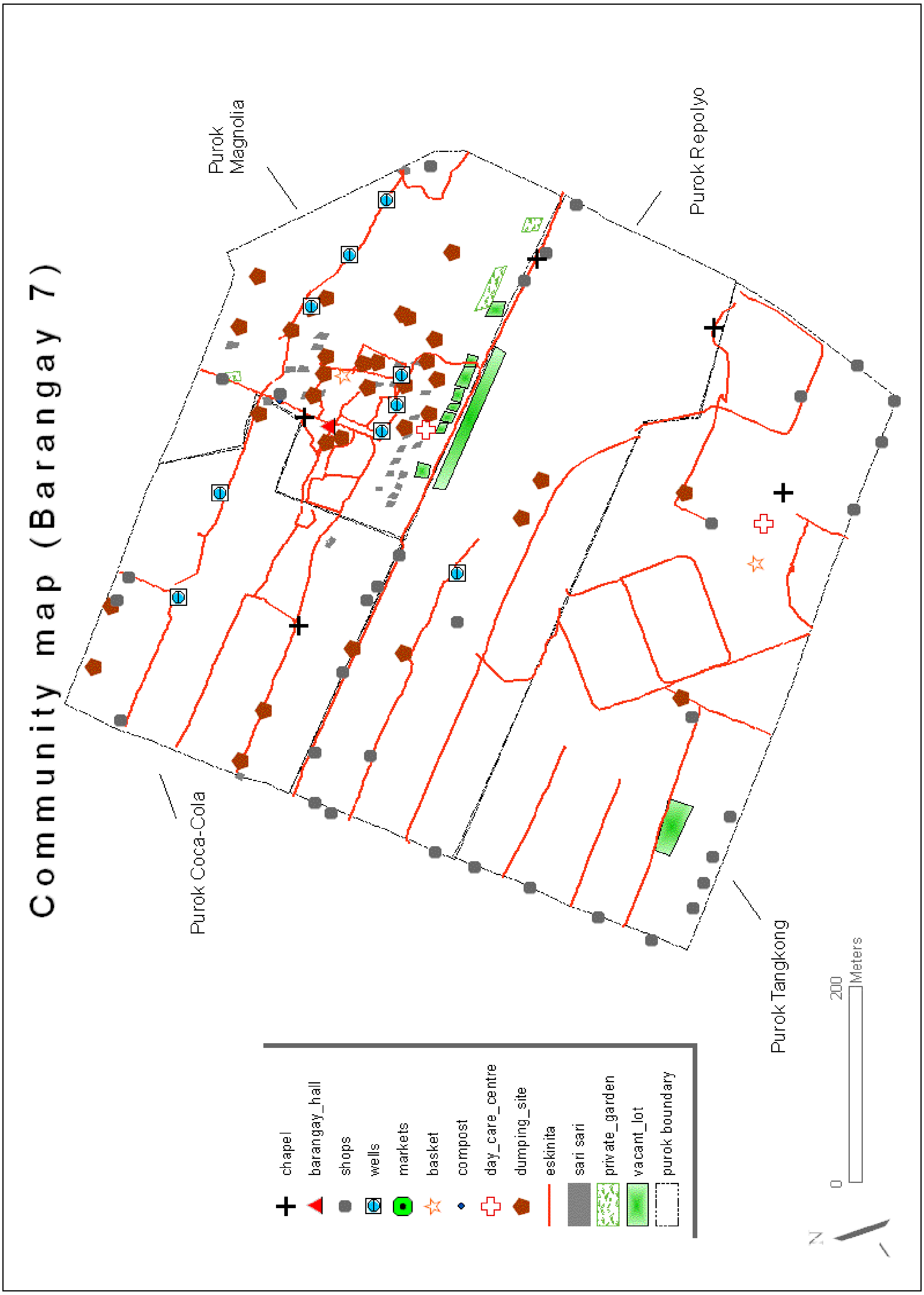

Figure 6.8: Digitized Community map of the Barangay 7

1) Density of Interest Indicator (DII)

A DII has been calculated for each purok through the interpretation of their mental representation of their expectations and daily lives. The features drawn are classified into four different domains with predefined weights.

Each domain is composed of several elements with a weight attributed by the women in charge of the FGD within Barangay 7. For each element, the higher the weight, the higher its importance to the community.

Features	Weight
Social Services Infrastructures	50
SWM	25
Economic features	15
Allotment garden	10

Table 6.12: Four domains and associated weight of the community map

In Barangay 7, the FGD selected some specific features belonging to the four different domains and attributed various weights giving more importance to the chapel, the basket ball court and the day-care centre.

Domain	Feature	Weight
Social services infrastructures	Barangay hall	7
	Basket ball court	7
	Day care centre	9
	Chapel	10
	Foot path	8
	School	9
Sub-total		50
SWM	Redemption centre	5
	Residual waste bin	5
	Compost facility	5
	Billboards	5
	Dumping site	5
Sub-total		25
Economic	Commercial establishments	5
	Sari-sari store	5
	Food vendors/ food stores	5
Sub-total		15

Allotment garden	Vacant private lot	2
	Water point (deep well, artesian…)	3
	Privately cultivated garden	2
	Electric source	3
Sub total		10
	TOTAL	100

Table 6.13: Detailed specific weights of the features of the community-based map

The Community-based map provided a way to select adequate zones as local communities gave a positive value to elements located in this zone. For instance, working near the basketball court may encourage gardeners' working motivation, as they like to be near it. Moreover, children who accompanied parents could play inside the court. The chapel may also be a source of inspiration for people. Nevertheless, the weak awareness about UA and SWM, underlined in the social survey, was also present in the DII. The community gave a little weight to each element of the 'allotment garden' domain. This is one of the difficulties of the community map process since even if not all the elements of the map are of interest to the scientist; they were kept as declared very crucial by the community. That is why weight operation and dialogue were time consuming parts of the process to ensure the participative approach.

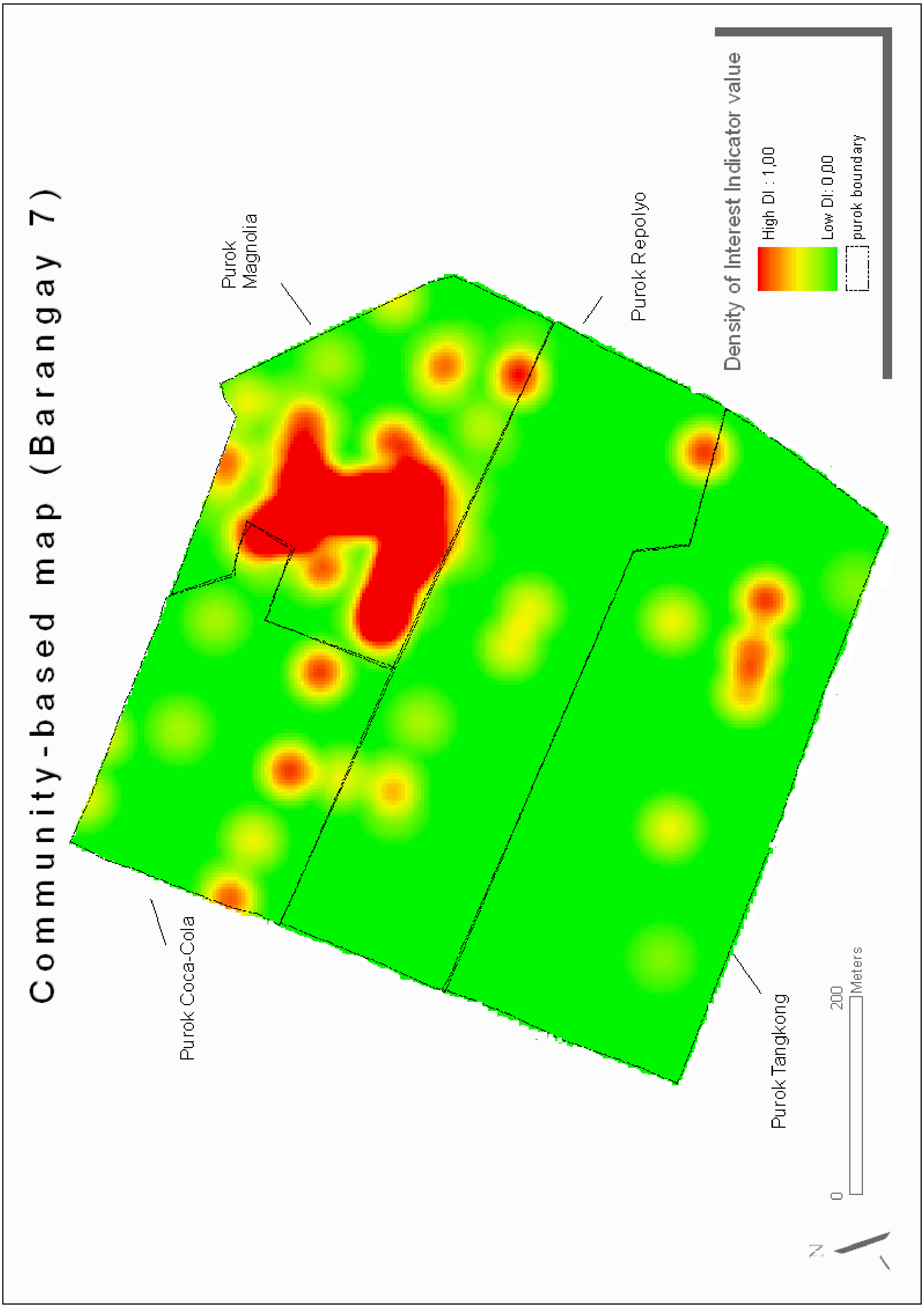

Figure 6.9: Community-based map (Barangay 7)

The Community-based map (Figure 6.9) is composed of circular density gradients around weighted elements, which have been standardized, of the Community Map itself. Density gradients allow the evaluation of where the density, and therefore the importance are for local people, was high with a continual gradient until the lowest density.

The greatest density spot was located in Magnolia. The most important elements according to the community were located in the purok Magnolia: the barangay hall and the basketball court. Magnolia therefore obtained a high status of importance. As this purok was also more motivated for the community mapping activity than other puroks, there are more elements drawn on this area. For example, in Coca-Cola, a GPS activity demonstrated that there is a basket-ball court but the community did not represent it. Therefore, the density in Magnolia was high. This is the second reason why the density of Interest Indicator is higher in this purok.

In Tangkong, there were fewer elements drawn by the communities but the basketball court obtained a high density.

For the purok Repolyo, the situation was worse with fewer elements with the lowest weights; dumping sites seem not to be important to the communities.

Coca-Cola had many elements drawn by the communities but with lower weights. After visualizing the map and strictly according to the communities' point of view, Magnolia is the priority location for implementing the project's allotment garden.

6.1.6. Output: Environment Social Community map (ESC)

Three combinations between suitability, social and community maps were proposed in total agreement with Balayan. The objective of the three combinations was to test extreme situations (priority social and priority environmental) and a neutral one.

A first combination (neutral, scenario a) gave the same weight to the technical side of the process as to the non-technical or social side. As the social side is composed of two elements, the social survey map and the community map, the weight given to the social aspect was divided by two. This combination had the advantage to be neutral in case of discussions with political leaders.

A second combination (environmental, scenario b) gave more importance to the suitability map (90%) and only 10% to the social aspect. This combination offered the possibility to produce a map with a low weight given to people in case of lack of volontee of leaders to give power to social aspect.

A third combination (social, scenario c) represented the opposite of combination b and gave only 10% to the suitability map.

Approach	Scenario	Combinations
ESC	a (neutral)	50/100 Suitability map + 25/100 Social + 25/100 Community map
	b (environmental)	90/100 Suitability map + 5/100 Social map + 5/100 Community map
	c (social)	10/100 Suitability map + 45/100 Social map+ 45/100 Community map

Table 6.14: Combinations for the ESC map

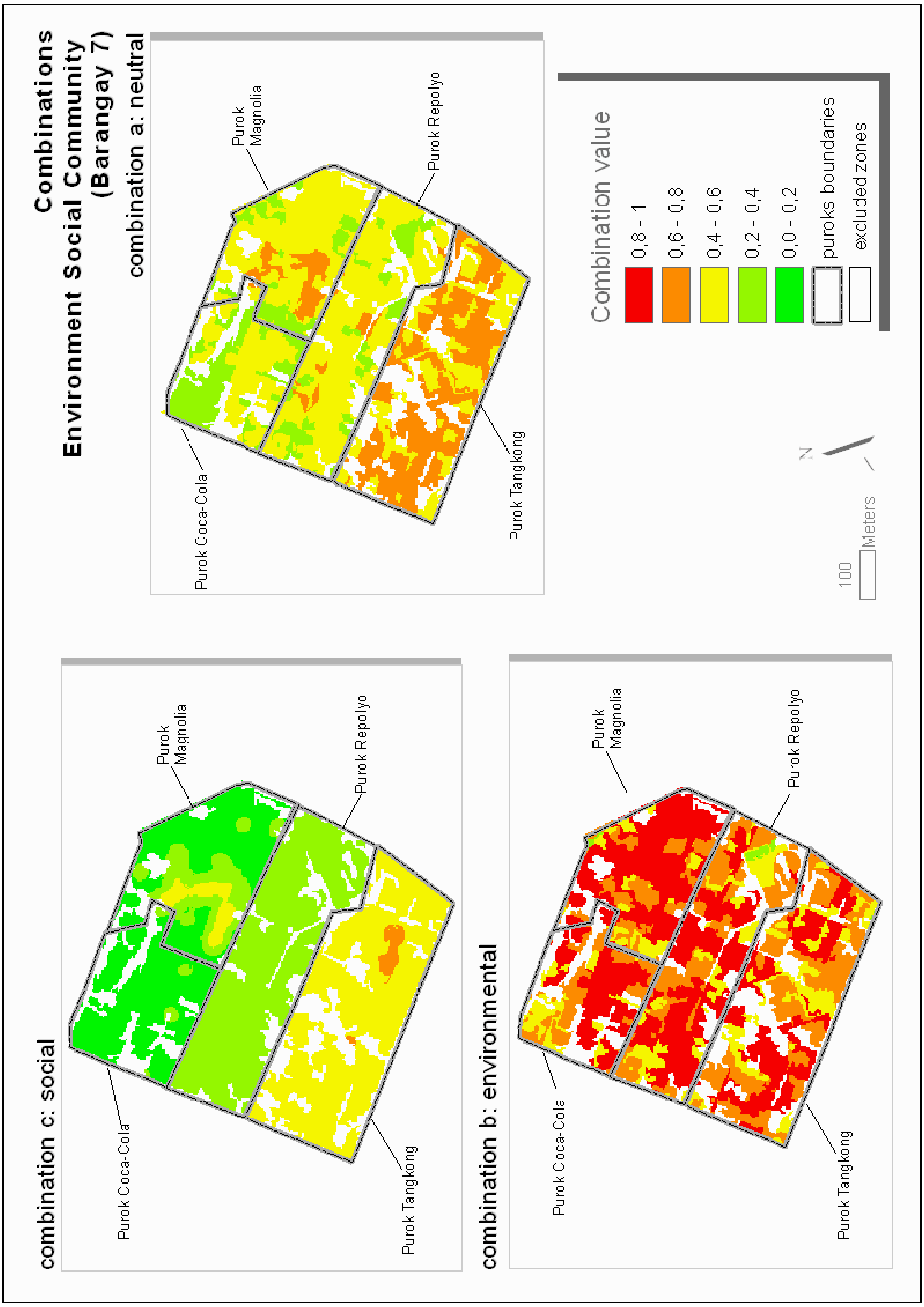

Figure 6.10: Environment Social Community combinations map (Barangay 7)

For easy understanding, the same scale was applied to all the combinations. Clearly, it appeared that 'combination b' obtaind the highest values for all the puroks, as the maximum value (1) was reached in all the puroks. At the opposite end of the spectrum, 'combination c' obtained the lowest priority as no zone obtained the maximum value. In addition, three puroks out of four were classified in the last two classes (between 0 and 0.4). Nevertheless, whatever the chosen combination by the decider, Tangkong got the relative value what means that southern purok revealed the highest priority for UA development. It showed clearly the superiority of Environment concern regards the social one.

With regards to the general objective of the current research, which is to empower marginalized populations with SWM and UA motivation and skills, it seems that the 'scenario b' should be proposed to local political leaders since Tangkong, which is the poorest is empowered and Magnolia, which is the most motivated is also classified as adequate in the combination.

If the decision-makers do not want to select a combination with a high suitability weight, 'scenario a' is more suitable as all the classes of value, except the highest one, are present, offering a large range of possibilities. If they want to choose a combination providing more power to communities, Magnolia is empowered by the influence of the good DII in the purok.

If a large lot must be selected in order to implement UA, more opportunities are present in combinations 'a' and 'c', but with weak values, since in the 'b' combination is more an accumulation of small patches.

Repolyo, Coca-Cola and Magnolia are more suitable from an environmental perspective than from a social perspective.

From another point of view, combination c obtains the lowest value even if more power is given to the social side of the combination. It seems that technical data related to the environment are dominating the decision in general.

6.2. Statistical Spatial Index approach (SSI)

The second approach, SSI Statistical Spatial Index, combines a Statistical methodology using the social survey as input and a computation of landscape spatial index issued from a classification of a remote sensing image.

This approach is mainly socially and technically anchored. The government partnership has been included in the consultation only. This allows testing the environment component from remote sensing perspective only and not from governmental census source which is less time consuming.

6.2.1. Data gathering for the SSI approach

Data from NGO/Community source	Details	Use
Social Survey (cf. Appendixes 5a & 5b)	Date of acquisition: 2003 Information about households, food/nutrition, income, jobs, health, agricultural uses, housing characteristic and community resources	Statistical map Map of a PCA process results in order to estimate the social status of the pilot site (Barangay7)

Table 6.15: Data from NGO/community source for the SSI approach

Data from external source	Details	Use
Remote sensing satellite image (Appendix 6)	Area: Bacolod, Philippines Collection date: 10/10/03-28/10/03 Sensor: Quickbird 2002 NW Corner: 10.7029, 122.926 SE Corner: 10.6141, 123.023 Product type: Standard 2A (Bundle) Resolution: Multispectral, 2.44-2.88 meter; Panchromatic, 61-72 cm	Spatial Index map Estimation of social classes through landscape index computation (Barangay 7)

Table 6.16: Data from external source for the SSI approach

6.2.2. SSI approach chart

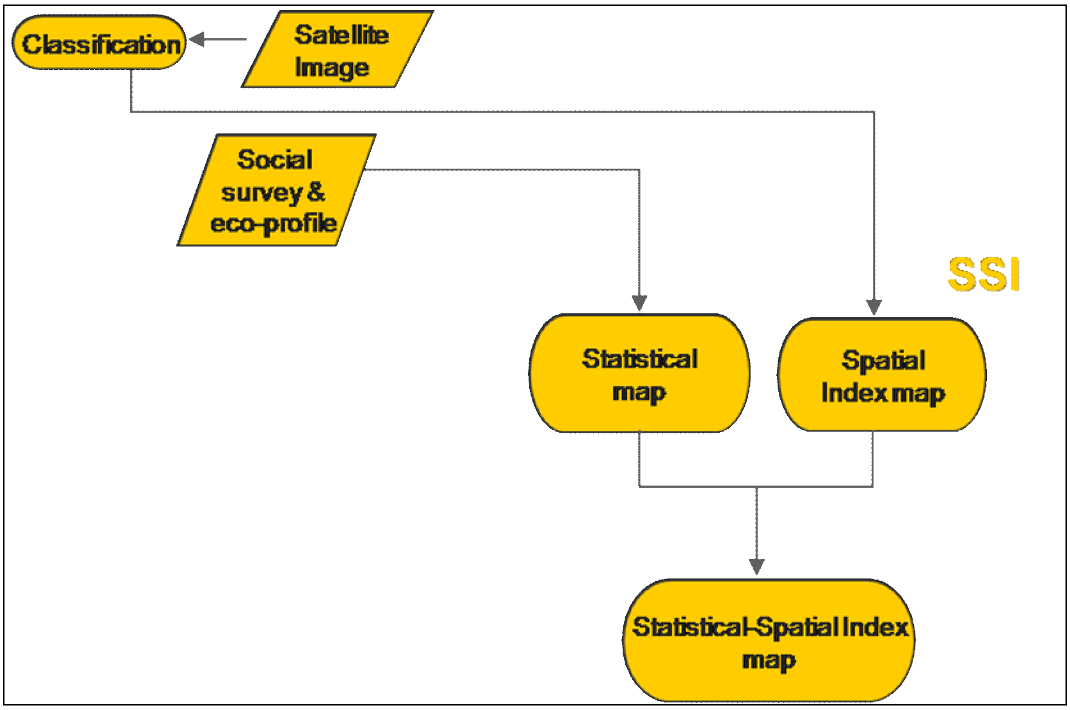

Figure 6.11: Chart of the SSI

6.2.3. Statistical map analysis

The principal objective of the next map is to statistically and socially classify the puroks, through the social survey with the help of PCA process. Pilot puroks are characterized by their motivation for waste segregation, the level of education or social characteristics.

Thanks to the answers collected with the social survey, a social priority may be given to the purok which has a certain level of education combined with a high degree of motivation for waste segregation linked to the objectives of this thesis.

In the PCA map, 19 variables have been included in order to reduce the information compiled in the social survey. All those variables are represented by a percentage coming from the social survey answers (Appendixes 5 and 8)

Name	Definition	Justification of use
Elementary level	Persons who studied in the Elementary level (%)	Indication of education level
High school level	Persons who studied at high school level (%)	
College level	Persons who studied at college level (%)	

Siblings 0-2y	Number of 0-2 year old siblings (children) (%)	Indication of free time for UA linked to the age of children or siblings
Siblings 3-8y	Number of 3-8 year old siblings (children) (%)	
Siblings 9-14y	Number of 9-14 year old siblings (children) (%)	
Houses and home lot rent	House or home lots owned (%) in the purok	Indication of purok social status (CHAPMAN, 2003) (TIWARI et al, 2005)
Houses and home lot owned	House or home lots rent (%) in the purok	
Squatter	Squatter (%) in the purok	
House in cement	House made of cement (%) in the purok	Indication of purok social status (CHAPMAN, 2003) (TIWARI et al, 2005)
House in wood-cement, wood	House made of wood, wood and cement (%) in the purok	
House in light materials	House made of light materials (%) in the purok	
Garbage selling	Household which burns, buries or throws away garbage (%)	Indication of SWM and UA people motivation and knowledge
Garbage burned, buried, throw away	Households which compost and recycle garbage (%)	
Garbage composted, recycled	Households which sell garbage (%)	
Conscious of waste segregation	Households which are conscious of waste segregation	

Motivation for segregation: health, cleanliness	Households whose motivation for segregation is health and cleanliness in the purok (%)	
Motivation for segregation: money	Households whose motivation for segregation is to earn money (%)	
Motivation for segregation: SWM	Household whose motivation for segregation is SWM (%)	

Table 6.17: List of variables for the PCA

Given that only 4 puroks are available in the Barangay 7, a PCA performed on 19 variables does not make much sense statistically. Indeed, in the same way that a correlation between two variables requires at the very least 3 points, analyzing the correlation matrix of 19 variables, requires to have at least 20 points, and ideally at least twice that number (NAUDET, 1999).

However, it seems interesting, for methodological purposes, to carry out a model analysis and to present its interpretation, allowing researchers who would like to continue the current research to implement the project with more data. Moreover, it will allow to highlight the redundancy among the variables in order to reduce their number list for further replication.

To this end, data are simulated in order to generate fictitious puroks similar to the 4 existing puroks. These 4 original puroks represent templates of 4 potential population around which experimental variability is simulated. In order to do so, random values following a normal distribution have been generated around the observed value for each purok, which therefore considered as the average of this fictitious population. Ten fictitious puroks per real purok were simulated. Only values within one standard deviation of the average were chosen for the complete matrix (0,2). The value of each variable in each purok represents the mean of the normal distribution.

Therefore, it is a simulation of fictive regions that will be composed of fictitious puroks; each simulated region will be, on average, what is observed in each real purok.

The matrix of data has a dimension 19 x44. The conclusions drawn from the analyses are purely illustrative.

	F1	F2
Eigen values	3.432	3.030
Variability (%)	18.061	15.949

% cumulated	18.061	34.010

Table 6.18: Component contribution to the variance of the two first variables (latent roots or eigenvalues)

Thanks to the variables coordinates or the correlation between components and variables, a specific orientation may be given to both components. As exposed in the following table, the first component is positively correlated with the ‘elementary level’, adequate garbage segregation and with the ‘squatter’ variable. Therefore, the first component represents people with a low education in unstable social situation as represented by the squatter variable and motivated for SWM.

The second component is well correlated with the ‘motivation for SWM: health’ variable. The variable ‘motivation for SWM: money’ is negatively correlated to the second component. Nevertheless, there is a certain correlation with the variable ‘adequate SW segregation’ and ‘cemented houses’.

	F1	**F2**
Elementary level	0.763	0.076
High school level	-0.410	0.301
College level	-0.377	-0.031
No of siblings per hh (0-2y)	-0.139	-0.084
No of siblings (3-8y)	-0.315	0.129
No of siblings (9-14y)	-0.379	0.192
House and home lot rent	-0.352	-0.193
House and home lot owned	-0.486	-0.244
squatter	0.710	0.233
house in cement	-0.112	0.573
house in wood, wood-cement	0.519	-0.506
house in light materials	-0.095	0.228
garbage selling	-0.340	-0.419
garbage and segregated waste burning, burying, throwing away,	-0.144	-0.633
garbage and segregated waste: compost, recycle, garbage can, eco-centre	0.619	0.430
segregation Y	-0.562	0.030
motivation for SWM: health	-0.204	0.905
motivation for SWM: money	0.334	-0.676
motivation for SWM: WM	-0.365	-0.216

Table 6.19: Correlations between variables and components for the kept components (component loadings)

As seen in the figure 6.12, all the puroks and their associated sub-regions are divided into four quadrants. As the priority of the research is SWM motivation and poor population, represented by the first quadrant (I), Tangkong is the purok corresponding to the target of the current research. Even if the purok is in the quadrant with a positive relation with cemented houses. This may be due to the presence of rich houses in some parts of the purok.

The purok Repolyo obtains the second best value, as it is located in the second quadrant representing people with low education levels and in squatter situations. Nevertheless, people segregate well their garbage with a lucrative motivation as represented by the second axis.

Magnolia is located in the third quadrant dedicated to people with a high education level, in a stable social situation but with health concern as SWM motivation.

The last quadrant, in which Coca-Cola is located, is based on non-squatter people with high education levels but with money as SWM motivation. Nevertheless the money factor influences their way to segregate garbage.

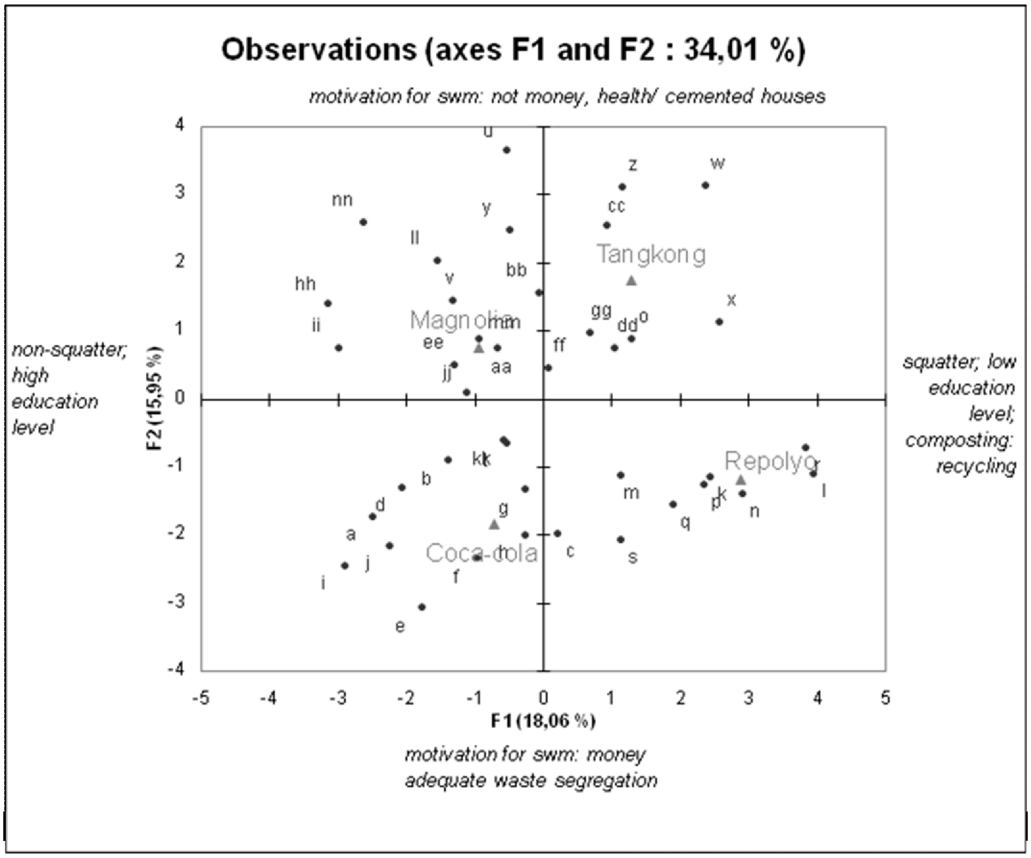

Figure 6.12: Representation of the individuals in the F1/F2 plan

The following table indicates the coordinates of all puroks in the F1/F2 plan :

Observation	F1	F2
Coca-cola	-0.723	-1.836
Repolyo	2.892	-1.182
Tangkong	1.276	1.744
Magnolia	-0.938	0.757

Table 6.20: Observations coordinates

In order to map the position of four puroks in the four quadrants, a weight is given to each factor, positive and negative. All the weights are linked to the specific objective of this research (cf. 5.2.1). As explained above, priority is given to a positive SWM motivation, a non-lucrative one, or a squatter with a low education level. In terms of this research, 'F1positive' and 'F2 positive' have nearly the same importance, 80 and 90, as the target population must firstly be motivated by SWM and secondly be poor people.

	Weight
F1 positive	80
F1 negative	30
F2 positive	90
F2 negative	60

Table 6.21: Factors weights

The mapping process is established by a process of combining the puroks' weights and coordinates, and completed by a classical normalization process.

Observation	F1	F2	weighted coordinates	Normalized value
Coca-cola	-0.72	-1.8	(-0.723*30)+ (-1.836*60)= -131.87	0
Repolyo	2.89	-1.18	160.38	0.75
Tangkong	1.28	1.74	259.00	1
Magnolia	-0.94	0.76	40.03	0.44

Table 6.22: Observations coordinates

Tangkong and Repolyo are the priority puroks in the principal component process, followed by Magnolia and Coca-Cola. The strong value of Tangkong is due to the high correlation between the purok and the two positive factors. At the opposite end of the scale, Coca-Cola is the low priority, due to the fact people are non-squatter and have a high education level.
By comparing the Statistical map and the Social map, it may be highlighted that the situation of Magnolia and Coca-Cola is different on both maps as a different set of data has been used. It is important to quote that both processes confirm the priority if the South of the Barangay 7 for UA and SWM practices development.

Moreover, 19 variables were used for the PCA analysis. It may be judicious to reduce the number of variables in order to avoid information redundancy. The level of education might be analyzed with two levels only such as elementary and high school, the two extremes. The free time for UA implementation might be computed with variables such as: household with children and household without children. Squatter variable might be the only variable used for the estimation of the purok social status.

Nevertheless it seems to be important to keep all the variables in order to evaluate the type of motivation for SW. Even if people well segregate their garbage, it may be due to the money attraction.

This variables reduction could be integrated in further replication of the methodology in order to have an easy and strong PCA interpretation.

Figure 6.13: Statistical map (Barangay 7)

6.2.4. Spatial Index map analysis

The objective of this computation is to identify rich and poor zones in the Barangay 7 through landscape characteristics extracted from a remote sensing Quickbird image in order to shortcut the ESC long suitability map building. A land use classification performed through an object-oriented classification is used as information for the calculation of shape indices.

1) Mean Shape Index

In relation with the assumptions (cf. 5.2.2) which assume that rich people are living in large house patch mixed with garden patches , only land use 'houses' and 'gardens' are extracted from the classification for the spatial index computation.

This index allows to identify different classes of regularity in the landscape whose are identified as different poverty classes.

A shape index is needed in order to quantify landscape configuration in terms of the complexity of patch shape at different levels of analysis. This index measures the complexity of a patch shape comparing it to a standard shape (cf. Appendix 2).

This may introduce a difference between rich 'houses patches' and poor 'houses patches' according to the assumption that rich people are living in large and regular-shaped area.

If the MSI=1, the patch is richer than those with a MSI superior to 1.

The relationship between houses and gardens, as exposed in the second assumption, is evaluated by the distance between garden and houses with a simple 'straight line distance' function. The closer the garden is to the house, the richer the zone is.

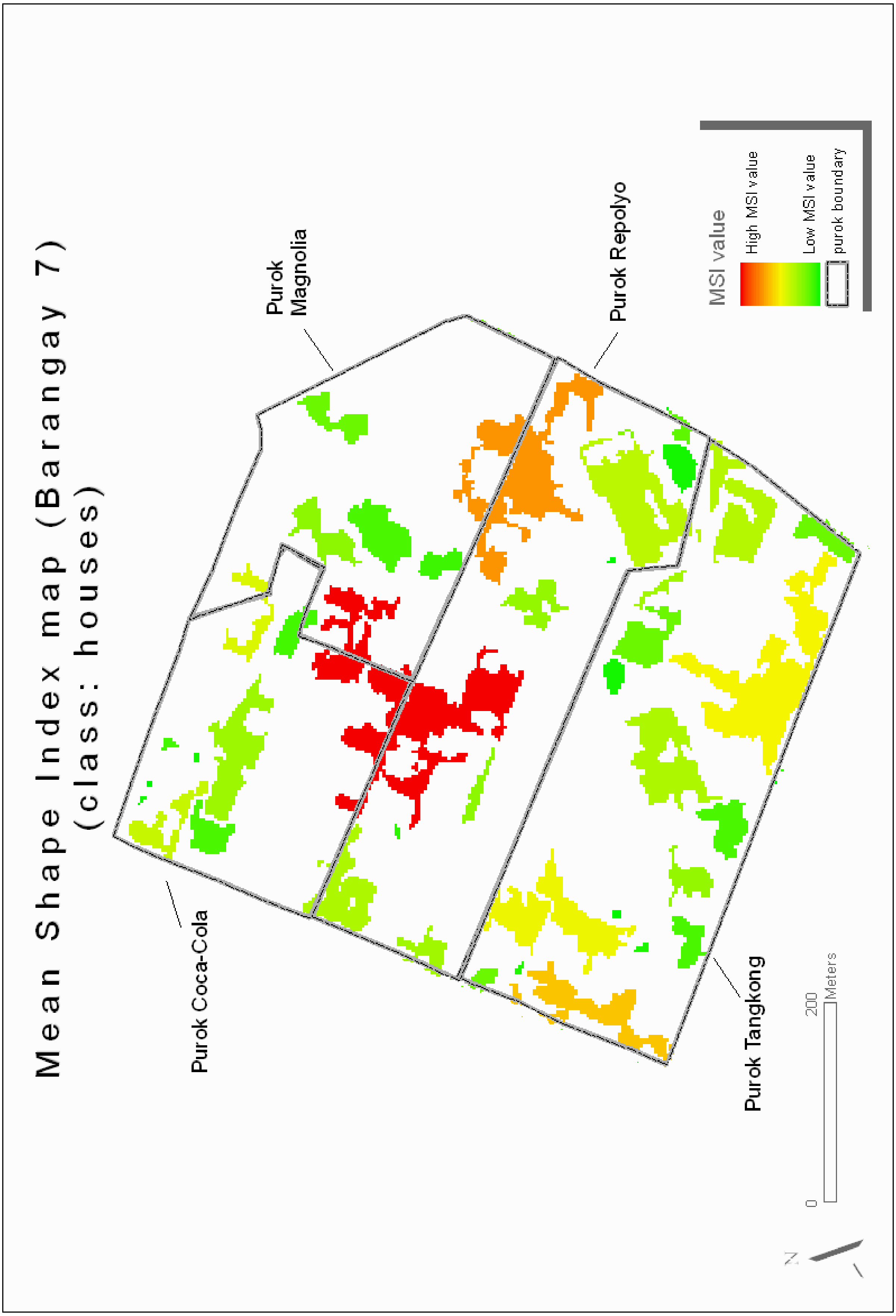

Figure 6.14: Mean Shape Index map

The shape of the houses are analyzed in order to tie in with the assumption that maintains that regular shaped houses are owned by rich people. This shape regularity is given by a 1 value for MSI. With a MSI equals to 1, houses are regular, above 1, houses are irregularly shaped. As the objective of the research is to focus on poor people, MSI values greater than 1 represent the target houses. Looking at figure 6.15, the highest values are represented in Magnolia, Coca-Cola and Repolyo. The social survey validated that in these three puroks, none or very few of the houses are made from cement thus accounting for the houses' irregular shape. In Tangkong, the situation is quite different due to the presence among large squatter zones of fewer but very large houses belonging to richer people. Nevertheless, all patches of Barangay 7 are irregular since all the values of MSI are greater than 1.

The assumptions related to the spatial index method have been checked at the end of the process. A direct check after the map realization would have been done, but, in general, the working context does not allow it. In the case of Barangay 7 it seems that the assumption that maintains that a regular shaped house is a richer house is partially verified. Compared to the reality, some zones classified as poor are really squatter zones (ellipses on the Figure 6.15), while some zones classified as poor are in fact commercial areas (rectangles on Figure 6.15). Moreover, a pinked dotted line represents zones, which have not been identified by the classification process. This infers that scientists have to be conscious that they are working with data (for instance, remote sensing classification) which is not 100% accurate. This is one of the understood assumptions of the methodology.

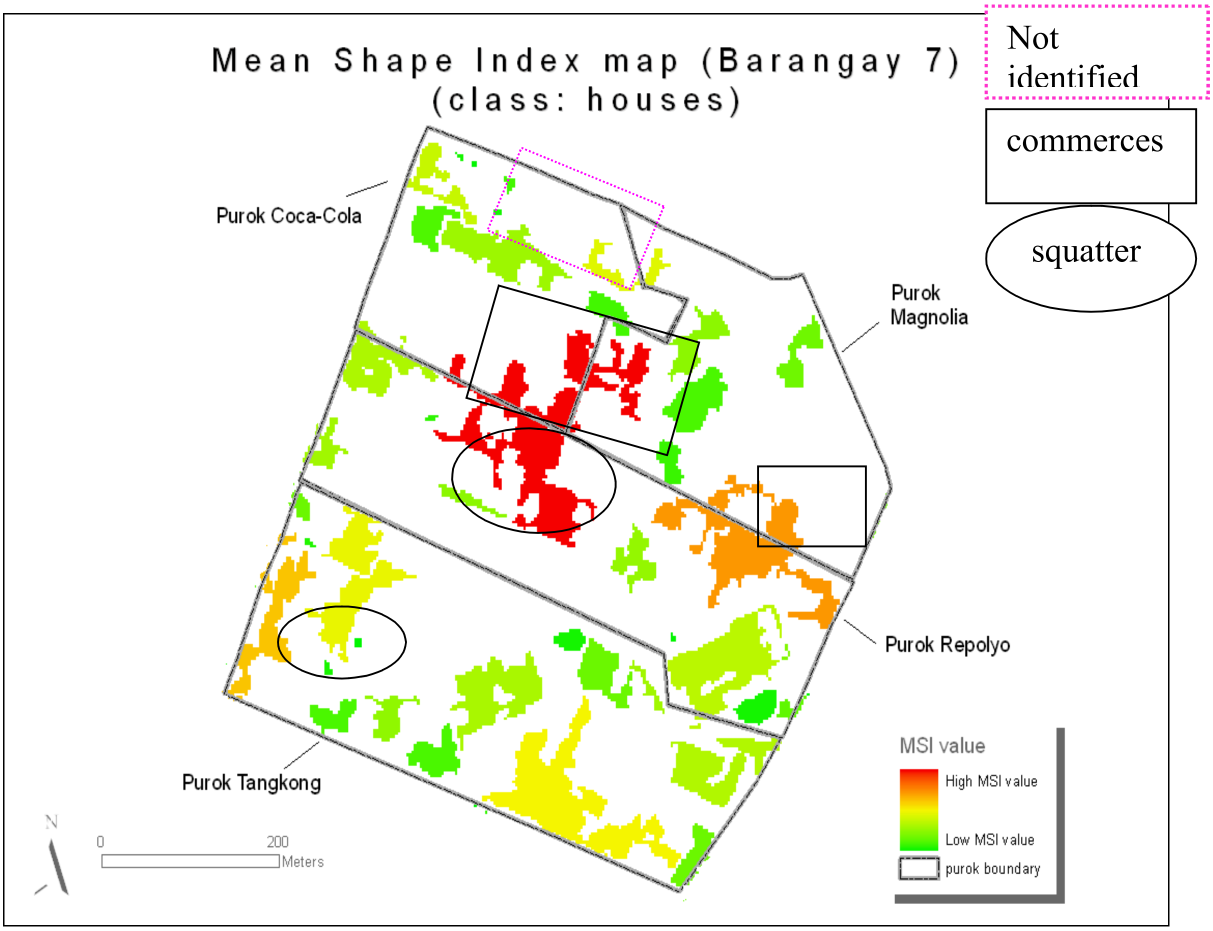

Figure 6.15: Validation of the assumption about house shape

2) Straight line distance map

The second assumption inspired from the landscape identifies rich zones with a nearby garden. The straight-line distance from the garden, mapped by a buffer technique, may help to identify rich zones since the farther the garden is from the house, the poorer the zone is. The classification of the Quickbird image identified many gardens in the eastern part of Barangay 7, especially in the Magnolia purok with a demo-garden. In Repolyo, many gardens are also present. In Tangkong and Coca-Cola, few gardens are present; zones inside both puroks obtain a high value for the Straight-line distance identifying poor zones.

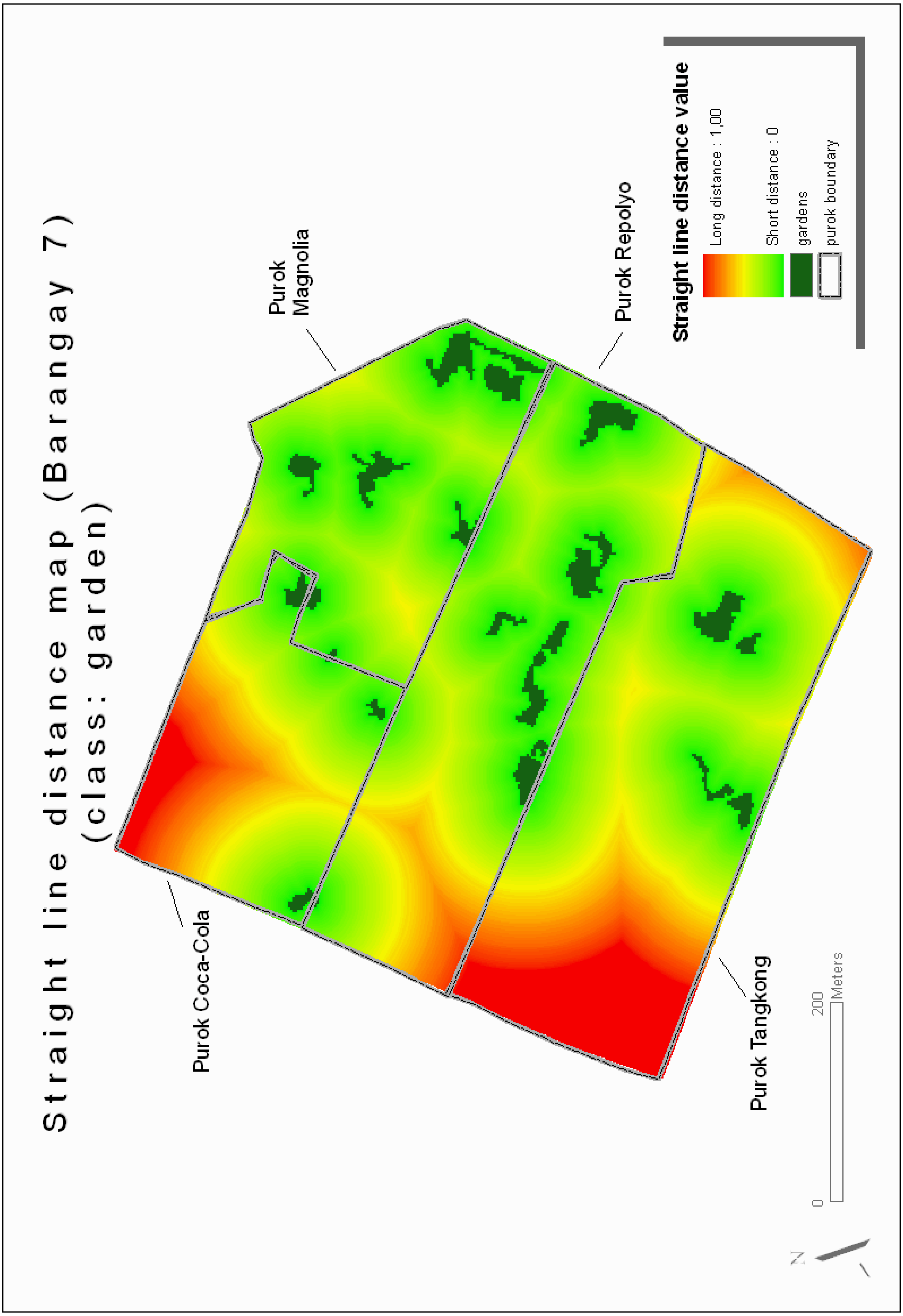

Figure 6.16: Straight-line distance from gardens (Barangay 7)

3) Spatial index map

Combining Straight line distance map with the Mean Shape Index map allows respecting both assumptions. This combination is a simple normalized sum of the Mean Shape Index map and the Straight Line Distance map. No weight is attributed since no priority is identified in terms of the exposed assumptions.

MSI	SLD	Spatial Index
Values between 0 to1	Values between 0 to1	SI=MSI+SLD Values between 0 to 1
No data	Values between 0 to1	SI=SLD Values between 0 to 1

Table 6.23: Spatial Index values

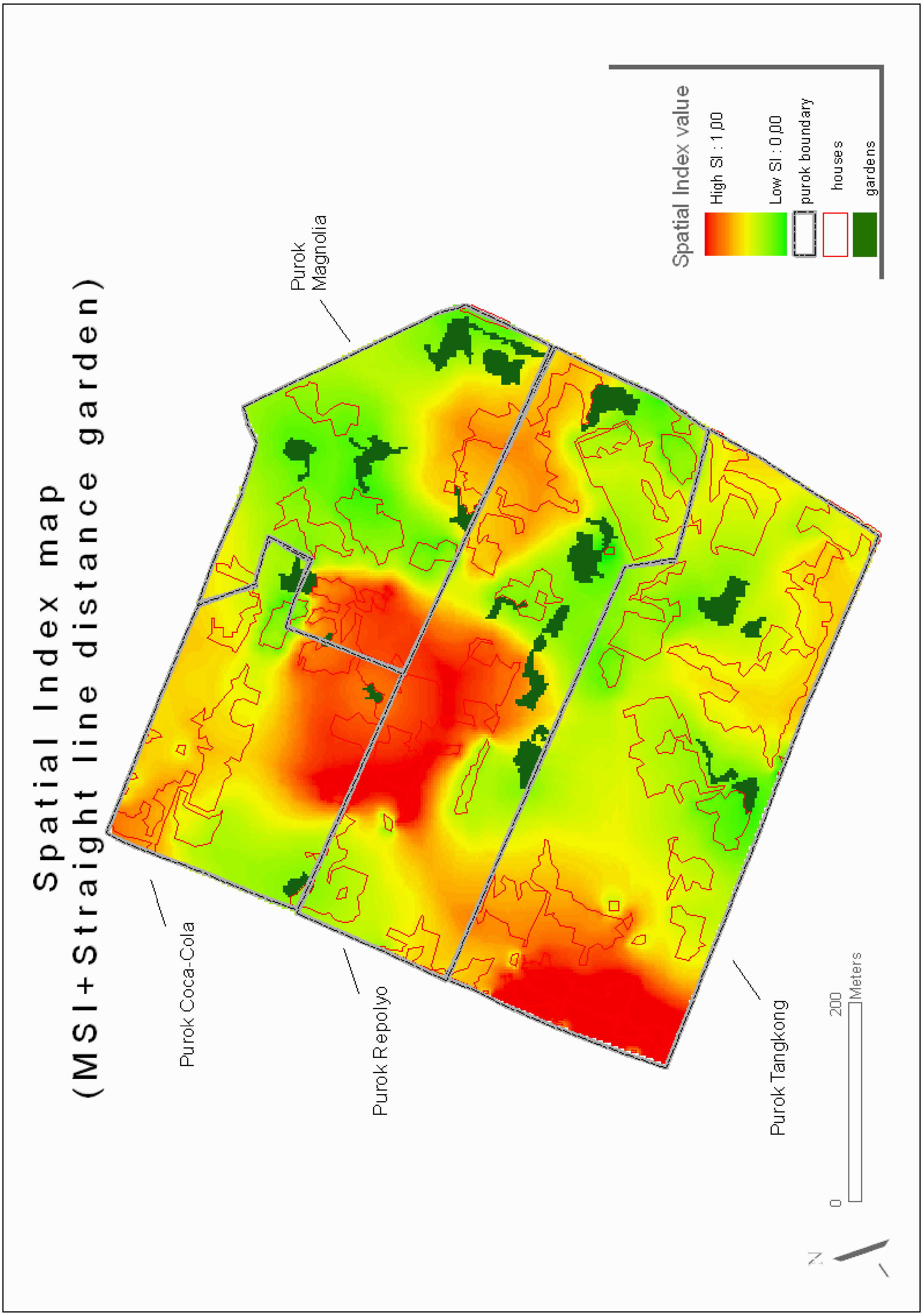

Figure 6.17: Spatial Index map (Barangay 7)

A zone with highest value appeared at the centre of the three puroks, Coca-Cola, Magnolia and Repolyo. This zone has been identified as a commercial area but also as a squatter zone (cf. Figure 6.15). The zone has been identified as a poor zone due to the presence of irregular houses but as there is a garden inside the zone, people's daily life may be enhanced by the garden as a garden is a source of food security. In the case of the commercial area, this is not true because the zone has been fenced in, in order to evict squatters from around the shops. For the upper part of the zone, the daily life of the community is good but this may not only be due to the presence of the gardens. The patch located in the south-south-east part of Magnolia is related to the presence of demo-gardens. Clearly it creates a better living environment for local communities who are able to sell vegetables at the local markets. Excluding the zone on the western side of the purok, which is a commercial area, Tangkong is identified through SI map as a relatively rich purok with a low Spatial Index. Globally Magnolia also shows a low value of Spatial Index (expect west zone), due to the absence of house patches identified as poor and therefore, the value of the SI is only given by the Straight Line Distance from the garden, which is also a low value as many gardens around.

The identification process confirmed that Magnolia is an adequate zone for UA implementation while Tangkong was identified as a rich zone.

6.2.5. Output: Statistical Spatial Index map (SSI)

The Statistical Spatial Index map is a weighted combination of the Statistical map and the Spatial Index map. This Statistical Spatial Index map represents a way to confirm or reject the results from the ESC methodology.

Several combinations are proposed in the general methodology based on discussions with the Filipino NGO. Three scenario are computed: the 'scenario a' which is the neutral one, the 'scenario b' which is the environmental one due to the 90% given to Spatial Index map and the 'scenario c' which is the social one due to the 90% given to Statistical map.

The first one (neutral, a) gives the same weight to Statistical and Spatial Index maps, the second (environmental, b) gives more weight to Spatial Index map and the third one (social, c) is the opposite of the second with only 10% for environmental information coming from the Spatial Index map.

Scenario	Statistical map	Spatial Index map
a (neutral)	5/10	5/10
b (environmental)	1/10	9/10
c (social)	9/10	1/10

Table 6.24: Combinations for the SSI approach

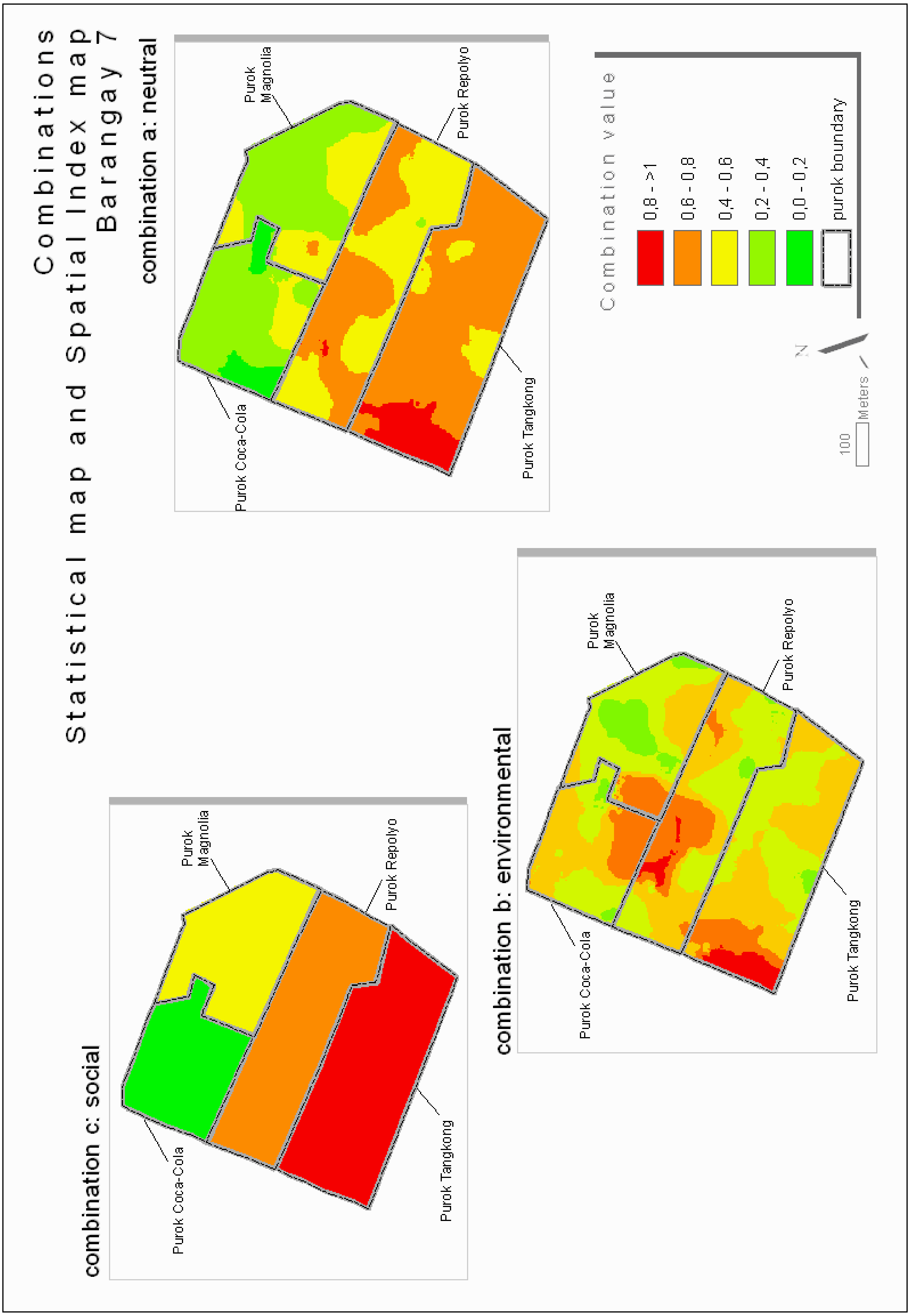

Figure 6.18: Statistical Spatial Index combinations map (Barangay 7)

If more weight is given to the social side (scenario c) of the method by giving a high weight to the Statistical map, the result is almost a purok per purok result given to the scale of the data availability in the social survey. There is a progression regards the spatial outputs definition from the 'scenario b', through 'scenario a', until 'scenario c' in terms of results presentation.
With lower influences of social aspects (scenario b), the results appear per patch as spatial information is more spatially detailed. Tangkong presents low priority but other puroks, which have a low priority with other combinations, gain priority on the 'scenario b'. With this combination, the squatter zone identified in centre of the puroks, Magnolia, Coca and Repolyo, as the West of Tangkong as well, appear as the target of the current research.

Conversely, into the 'scenario a' (neutral scenario), the field validated commercial area obtains the highest value, which may lead to errors being made in the decision-making process since it was identified as a squatter area by SSI before field validation.

In the case of Magnolia, target purok of the research, this SSI approach seems not to give priority to plots located there. It could be due to the way of implementing social information. Magnolia was really motivated for the community mapping and therefore the first approach giving more importance to community participation was probably more adequate to integrate social views of target communities.

In the scenario c, only one plots located in the purok Tangkong seem to be adequate for UA implementation. It could lead to a restriction in terms of plots choice if the owners of plots located in the selected purok become opposed to a rent process what would bring deciders into an incentive procedure.

6.3. Profitability Survey approach (PS)

While the two approaches (ESC, SSI) select adequate zones from environment and social criteria, an additional economical approach might aim to balance values for some preselected plots in those zones.

6.3.1. Data gathering for the PS approach

An economical survey, (Appendixes 9a and 9b) has been conducted in the neighbourhood preselected plots by Balayan.

Data from NGO/Community and City government source	Details	Use
-Profitability survey (with the help of the City) (cf. Appendixes 9a & 9b)	-Creation date: 05/2005 -Per household per plot -Attributes: skills of people, chosen product by people to cultivate, risks for the plot, proximity of non-workers, use of the plot,	Creation of a Profitability Survey map

	transport mean, type of fertilizers	

Table 6.25: Data from NGO/Community and city government sources for the profitability survey map

6.3.2. PS approach chart

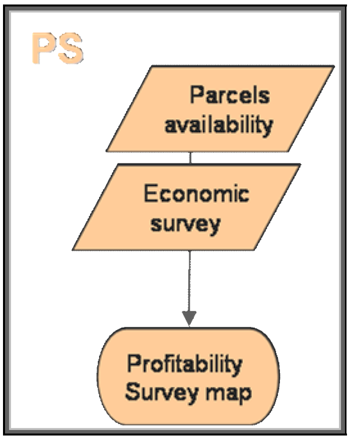

Figure 6.19: Profitability Survey methodology chart

6.3.3. Selection of plots and people

Based on criteria (free of occupation, open owner, etc.), some plots are selected by Balayan (Figure 6.20) and people around 20m from the plot were interviewed as the NGO evaluated this distance on the daily walking distance between plot and home.

The local NGO chose five plots plus the demo garden to implement the economic survey :

Vacant lot number[1]	Characteristics
Vacant lot 1	vacant lot with big houses surrounding it; size: 0.07ha
Vacant lot 3	they had been planting vegetables in the vacant lot but the owner stopped them and planted fruit trees; size:0.16ha
Vacant lot 5	vacant lot with wall surrounding it; size:0.02ha
Vacant lot 6	vacant lot which floods; Community were planting in an empty can so if it rained and they were floods, they could vacate their plants; most of them plant vegetables for their own consumption;

[1] Irregularity in the order of numbers is due to reject of some pre-selected plots according to the free-occupation criteria

	vacant lot with urban poor on the left side; size:1.13ha
Vacant lot 9	Vacant lot is prone to flooding; during rainy seasons, they do not plant vegetables; vacant lot surrounding by a wall but with houses to survey; best location for communities because near the barangay hall.; size: 0.22ha
Vacant lot 10	demo garden pre-selected; size:0.15ha

Table 6.26: Vacant lot characteristic

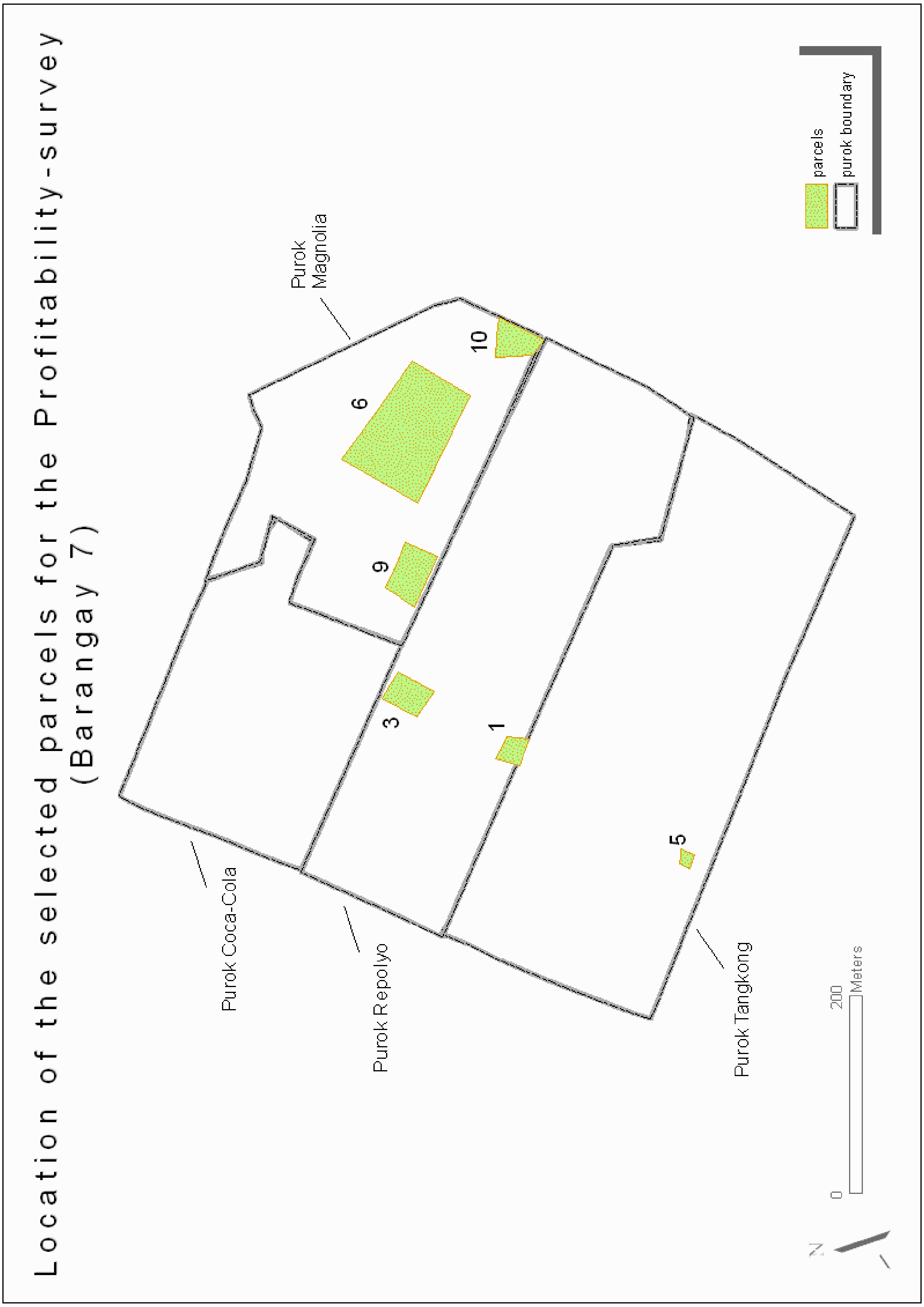

Figure 6.20: Location of the selected plots for the profitability survey in the Barangay7

In the context of Barangay 7, the economic survey sought to describe the economic characteristics of the vegetable growers, vendors and consumers. Moreover, with some questions, the vegetable production practices should be identified. Problems and threats that may be encountered are also analyzed.

In order to be statistically significant, the survey has been implemented in 33 households. The implementation in the model relies on an economical survey carried out by the local NGO under the supervision of specialists. For each pilot plot in Barangay 7, one person from each household is interviewed, without any consideration as to whether his/her principal activity was based on UA or not. Moreover, as seen in the following table, number of interviewed household is dependent on the presence of people at the moment of the survey.

Plot number	Number of households
1	4
3	6
5	7
6	7
9	5
10	4
Total	33

Table 6.27: Number of interviewed households per plot

6.3.4. Establishment of the Profitability Survey equation

The economic map is created through the computation of rent or profits. The principal specificity of the economic map is the integration of community data as well as business data by combining production cost and production value.
The PS is computed per plot (cf. Appendix 9b).

For the computation of the rent per plot, needed data is:

Production value :
- Skills: people answered from 0 to 10 (10 correspond to good skills)

- Types of products chosen by the communities (vegetables, fruits, crops, etc.) :
If people answered that they prefer to cultivate vegetables, the maximum value,10, is attributed. If they prefer to cultivate crops or fruits, 5 is attributed due to the fact that fruits are more perishable and 1 for flowers which are more a decorative purpose. Multiple answers are possible. The total obtain form the answer, per plot, is divided by the maximum that could be produce on each plot.

- Use of the plot: agriculture is the best use of the plot (used to estimate the quality of the plot). If people answered positively to the question, a value of 10 was attributed.

- Potential of the plots (fertility, floods, etc.): People classified the potentiality of the plots in terms of fertility (good fertility= 10) and floods (high potentiality of flooding=1). Fertility is weighted with 3 and flood with 7. The equation of 'potential' has this form: answer about fertility*7+ answer about flooding*3

- Regularity of the income in the neighborhood (used to estimate the proximity of possible workers): if people answered that they didn't have a regular income the value is 10 and 1 if they have a regular income.

PV= skills*production type*plots' use*plots' potential*income[1]

Production cost:

- Threats to the plots (ownership, permit to cultivate, etc.): As many economists have believed since the 80s, risks have to be taken into account in economical modeling. Typically, the farmers in developing countries are thought to be 'risk averse' which in turn implies that they are willing to forgo some income in order to avoid risk (COLMAN and YOUNG, 1989). Farmers are in an uncertain environment and will seek to maximize satisfaction or so-called 'utility'. If people answered that the threat is the lack of permit to cultivate or the land ownership, the attributed value is 10. If this is a problem of accessibility, specialists considered that this is a weaker threats and attributed value is only 5.

- Types of fertilizers (organic or inorganic): If people answered that they prefer to cultivate with inorganic fertilizer, attributed value is 10 and 1 for organic as organic fertilizers are prioritized in accordance with a sustainable urban agriculture.

- Fertilizer and knowledge: these two elements may be defined as economist technology, which may enhance production possibilities. Through technological change, production will shift considerably so that:
More output can be produced with the same quantity of inputs;
The same output can be produced with a smaller quantity of inputs.
The use of fertilizers is very complex. "Because farmers operate in a decision-making framework of uncertainty and limited funds, they often failed to use fertilizer inputs…as those recommended on the basis of trials" (HEADY and DILLON, 1966). A series of experiments is a good way to determine the best quantity of inputs.

- Transport mean (used to estimate the transport cost): If people answered that they go to their plots with no transport mean, the attributed value is 1. As jeepney is the most polluting used transport mean, a value of 10 is attributed to this answer.

- Accessibility: distance to eskinitas, wells and markets. Mean distances to eskinitas, wells and markets are calculated.

---

[1] Before the computation, each variable is coded from 0.01 to 1. As far as the PC is concerned, the people's perception shows very low values which reveals their disregards compared to their PV consideration.

(cf. Appendix 9b)

PC= plots' threats*fertilizers*transport mean*distances[1]

The general equation for the Profitability Survey index is therefore a simple subtraction of the production cost from the production value.
Profitability survey index = PV-PC=Skills * production type * plots' use * plots' potential * income – plots' threats * fertilizers * transport mean * distances

At the end, results should be balanced by a 'surface factor'. Indeed, if a larger area is available, first of all more fertilizers are needed but this cost must be diminished if there is a reduction in wholesale purchase. Secondly, more water is also required but the price of water is constant if it comes from the city but may be different if it comes from a private owner.

However, a larger area may have more workers even if too many workers might contribute to diminishing productivity.

Other data are available but not included in the computation of Profitability Survey index as similar for all plots: the cost of water (the same for all plots because all lands are commercial areas), the rent price of the land and tax (12% in commercial areas).

The computation per vegetable is very specific and, as some data are lacking for the computation of production cost specifically (materials (types and cost), human capital and transport costs) will not be performed.

Moreover, some indicators are very important but will not be take into account due to specificity of the domain, such as:

Water required for good gardening: it is ideal to know the water requirement for each vegetable. Households pay 110 phP/m^3/month to the water office of Bacolod. Water is computed since every vegetable has a specific need for water for its growth, particularly in a tropical climate.

The plot price is also a major factor in the computation of the profitability equation. Each selected plot in the barangay is a commercial area. The rent price in the '90s was 4000 hp/m^2, in 2005, that price had increased by 50% to 6000phP/m^2. An amount of 12% in taxes is added. As the price is related to the size of the plot and as the price is the same for each m^2, since all selected plots are commercial lands, it may not be useful to incorporate the price into the equation. However, some cases may be

---

[1] Before the computation, each variable is coded from 0.01 to 1. As far as the PC is concerned, the people's perception shows very low values which reveals their disregards compared to their PV consideration.

different in Bacolod, as there are different types of land with different taxes imposed on the plots :
- 8% for residential lands;
- 40% for agricultural lands;
- 50% for industrial lands.

The price is also linked to the process of economic scales. Clearly the larger the prevalent size of the plant is, the larger the market it can serve. It occupies fewer locations therefore, production is more concentrated.

Some points must be specified for a general application. For instance, some fixed costs have to be paid before activity can be implemented; otherwise no work will be possible. Moreover, in some cases, insurance cover must be taken out for materials and must be included in the fixed costs. The redemption of tools must also be included in the costs.

A more detailed analysis might be elaborated with the help of agronomist since it is clear that on plots number 5 and 1, only vegetables that do not require a lot of water, such as tomatoes, which grow well in sandy loam, can be cultivated as no well is located near the plot (333m). Plots 9 and 6 should be used for the cultivation of vegetables requiring water such as lettuce.

6.3.5. Output: Profitability Survey map (PS)

Figure 6.21: Per plot Profitability Survey map (Barangay 7)

Only six plots are available for the profitability survey. Plot 5 is the smallest with 200m² but it has the highest profitability profile. Plot number 6, the largest with 11000m², obtains the worst value of 0.18 in terms of profitability. Yet it should be emphasized that there is only a small difference, in terms of value, between the worst and best plot. The demo-garden identified in the purok Magnolia is not well classified in terms of profitability. Nevertheless, Magnolia's profitability profile is not that bad as three plots are available within the purok.

Plot 5 obtains a high profitability value, so high that even the elevated production cost does not affect the total value. The high production value is influenced by the type of products chosen for agriculture: vegetables, crops, fruits and flowers. The most influent variable for plot 5 is the proximity of non-workers established with the question related to the absence of regular income for interviewed people.

Plot 6 obtains the lowest value for profitability: more than the half of the interviewed people estimates that the plot is at high risk of flooding. Moreover, the plot's fertility score is 4/10. In the surrounding areas of this plot, more than the half-interviewed people have a regular income. As the objective of the research project is to provide job security through agriculture, non-regular workers have a higher weight than regular workers do.

In terms of plot 10, the low production value can be attributed to the low value for skills regarding agriculture. Moreover, people only chose one product for gardening and the balance between regular and non-regular workers is in the middle.

A discussion must be had as even if plot 6 is the worst in terms of profitability due to it being the largest plot; it offers more job opportunities to workers. A more detailed profitability analysis should balance profitability and size.

6.3.6. Barangay 7 Community-based Land Use Plan

The final objective of this research is to propose scenarios to the political deciders. In keeping with this idea, different scenarios for both approaches (ESC, SSI) combined with profitability (PS) will represent the Community-based Land Use Plan for Barangay 7.

All the combinations previously detailed will be combined such as: 80% Combination + 20% Profitability-survey map. This lower percentage for the profitability map is decided given the relatively general information providing by collected data. There is a lack of specific information per plot. Moreover, this third approach is less participative than ESC and SSI. Therefore, it is less in adequacy with the objective of the current research about PGIS use.

These two criteria lead to characterize the PS approach as an optional approach (dotted lines in the Methodological chart, Figure 5.1).

The CBLU Plan presented to decision-makers with all combinations are presented in the following table.

Approach	Scenario	Combinations
ESC	a (neutral)	80% (50/100 Suitability map + 25/100 Social + 25/100 Community map) + 20% Profitability survey map
	b (environmental)	80% (90/100 Suitability map + 5/100 Social map + 5/100 Community map) + 20% Profitability survey map
	c (social)	80% (10/100 Suitability map + 45/100 Social map+ 45/100 Community map) + 20% Profitability survey map
SSI	a (neutral)	80% (5/10 Spatial Index map + 5/10 Statistical map)+ 20% Profitability survey map
	b (environmental)	80% (9/10 Spatial Index map + 1/10 Statistical map) + 20% Profitability survey map
	c (social)	80%(1/10 Spatial Index map + 9/10 Statistical map)+20% Profitability survey map

Table 6.28: Proposed combinations in both approaches

6.3.6.1.Output: Environment Survey Community- -Profitability Survey combinations

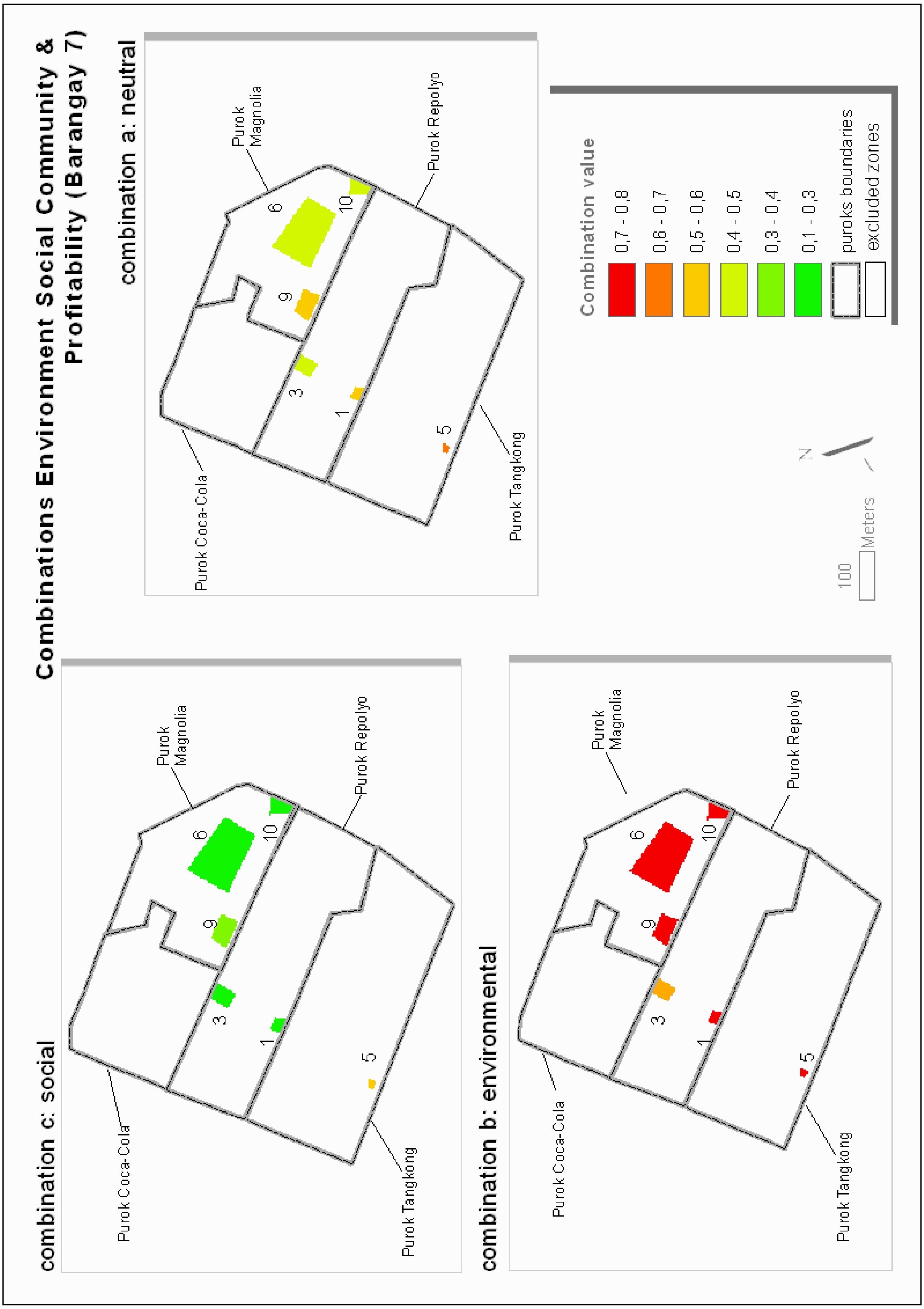

Figure 6.22: Combinations between ESC and Profitability Survey (Barangay 7)

Clearly, it appears that ‘scenario b’ (environmental scenario) gives priorities to puroks with plots 1, 5, 6, 9 and 10 (Figure 6.22). Moreover, this combination therefore gives priority to Magnolia, which is a target in the current research in terms of motivation for SWM and UA, even if in profitability terms it came off worst.

Since plot 10 is already cultivated within the purok, ‘combination b’ must empower the decision of the political leaders.

A high weight to environmental side or non-social data reveals a high potential for the entire Barangay.

If deciders give priority to the social aspect of the approach, like in ‘scenario c’, output values are lower. This conclusion might be due to the low awareness of people about SWM. Clearly Tangkong is the highest priority in respect of social profile. But people need to be trained or prepared with the perspective of enhancing UA if social aspects will prevail to environmental ones.

With the neutral scenario (scenario a), the values of the plots are eclectic, which is quite interesting if political deciders do not want to prioritize either environmental either social aspects.

However, whatever the choice of combination, plot 5 remained the plot to prioritize given its poverty, density and SWM motivation profile.

6.3.6.2.<u>Output: Statistical Spatial Index-Profitability Survey combinations</u>

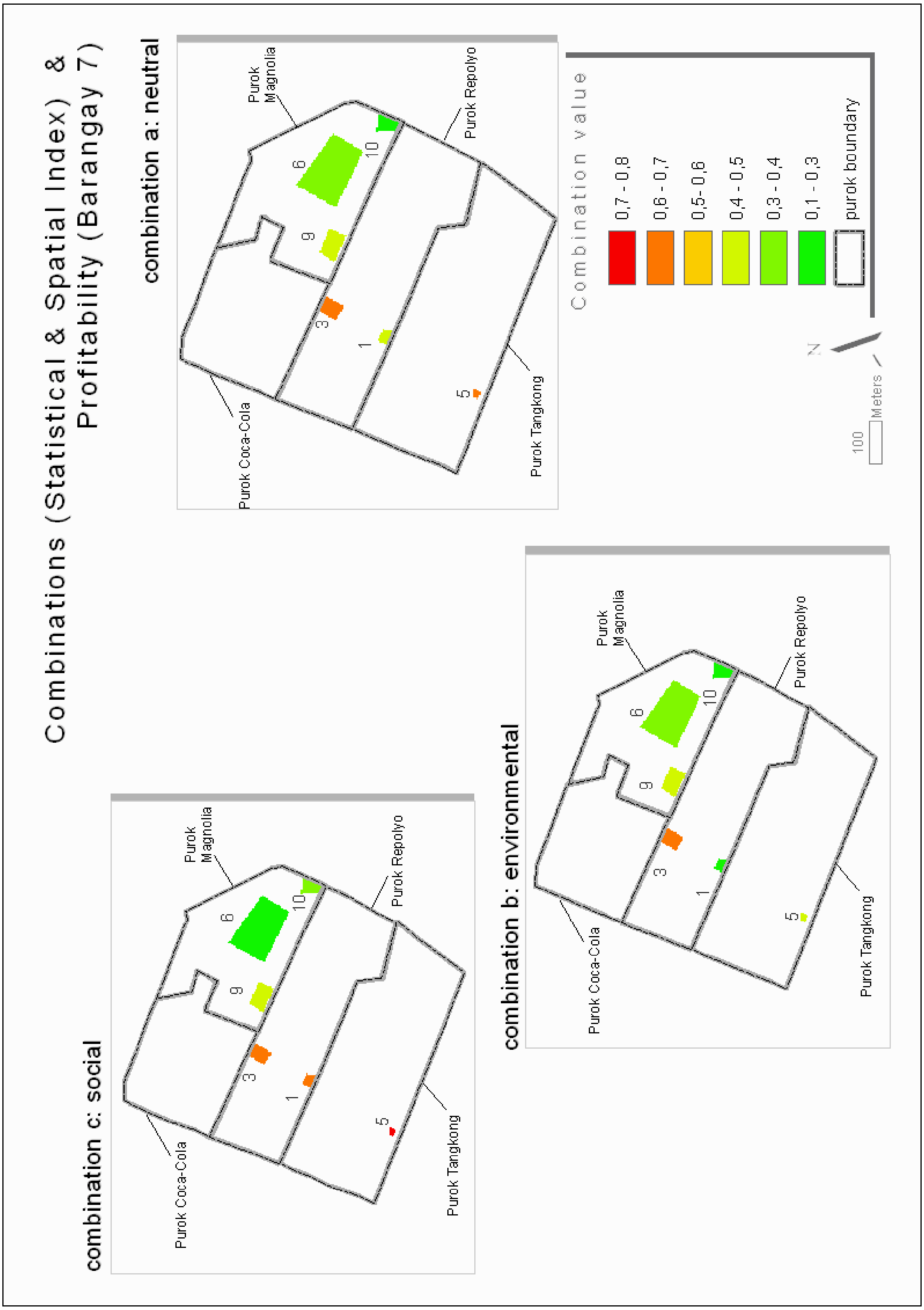

Figure 6.23: Combinations between Statistical-Spatial Index approach and Profitability Survey (Barangay 7)

The social scenario is recommended with one plot (the smallest one, plot 5), obtains the highest potential value. Plot 5 is not the priority for all combinations. Plots 3 and 1, with low weight given to environmental aspects, obtain high values for this approach, which is quite interesting if the owner of plot 5 is not willing to rent the plot.

Whatever the chosen scenario, plot 3 is still high priority and the demo-garden (plot 10) is one of the lowest priorities. This could explain why this plot is not use for UA anymore.

In order to choose an ideal scenario, it could be judicious to note that all the three scenario offers a panel of priorities but plots 6, 9 and the demo garden are still considered as the lowest priority for the current research. It is not favourable for the Purok Magnolia, where all 3 plots are located but, in this case, the motivation and the presence of previous SWM projects in the purok could influence the final decision independently from the model.

6.4. Pilot case findings and discussions

Before adding profitability data and comparing both approaches ESC and SSI, the two combinations giving the same priority to environment and to social aspects give the same purok classification, with Tangkong coming out our priority and Coca-Cola the last priority. For Repolyo and Tangkong, puroks obtain mean value but the zone in the south-western part of the purok has been identified two times as a very adequate zone for gardening due to the social status in adequacy with the target of the current research.

Comparing ‘scenario c’ (social) that gives only 10% to the environmental data of the methodologies, the ranking of puroks is the same for both approaches: Tangkong, Repolyo, Magnolia and Coca-Cola. However, in the ESC approach, small zones obtain a value adequate for urban farming.

With the ‘scenario b’ (environmental scenario) in the ESC approach, small patches adequate for farming are identified and in the SSI approach, larger zones are identified with the same value (Figures 6.10 & 6.18). However, in the ESC approach, the small adequate plots are spread over all the puroks. With the SSI approach adequate plots are only present into two puroks. This may lead to a lack of possibilities to practice urban agriculture in case of owner not decided to rent their plots.

With profitability data inclusion in the ESC approach, all the puroks and therefore all the selected plots get high potential whatever the scenario.

If only one map has to be presented to the political deciders today, we recommend ‘scenario b’ giving more priority to non-social data of the ESC/Profitability approach. In fact, all the selected plots have a high value in terms of Environmental suitability, Community approach and Profitability.

Nevertheless, in order to increase the participation, we highly recommend to improve the training of the communities; this will allow a more participative approach of land planning by shifting to scenarios maximizing social aspects ('scenario c' or at least 'scenario a') ensuring a planning decision in accordance with people's expectations.

Before any generalization is made about the approaches, a replication must be computed. Thanks to this operation, it should be possible to choose variables or weights for all simulation cases in the context of developing countries. In addition, it is possible to alleviate statistical bias due to a too small area like Barangay 7.

This replication is a key for the sustainability of the methodology.

Chapter 7. Replication

7.1. Context of the replication

A replication zone, the Barangay Bugo (Figures 7.1a & 7.1b), has been chosen based on specific criteria, same as Barangay 7: poor zone, urban zone, highly urbanized or involved in SWM project. Bugo is the boundary barangay of Cagayan de Oro to the east, which is approximately fifteen kilometers from the city proper. It has a land area of 968 square kilometers that is divided into eight puroks also called zones, including the sites of Suntingon, San Vincente and Kihapon. Specific studied zones are mapped on the Figure 7.1b.

Topographically, Bugo is bordered on the north by the town of Tagoloan, Misamis Oriental; on the south by barangay Puerto; on the east by the province of Bukidnon; and on the west by Macajalar Bay, Mindanao Island.

As one of the most largely populated barangays of the city, Bugo is categorized as a highly urbanized barangay. Its population totals 26,473 (As of Dec. 2005). Thus, more people imply more waste.

Data coming from the Asia Urbs projects is simply used as inputs in the general methodology, in the linear combination explained in Chapter 5. Weights attributed to different features are not discussed in the replication as they have been imported from the Asia Urbs project. Nevertheless, scenarios are the same as in Bacolod City in order to be able to discuss the results of the two study cases.

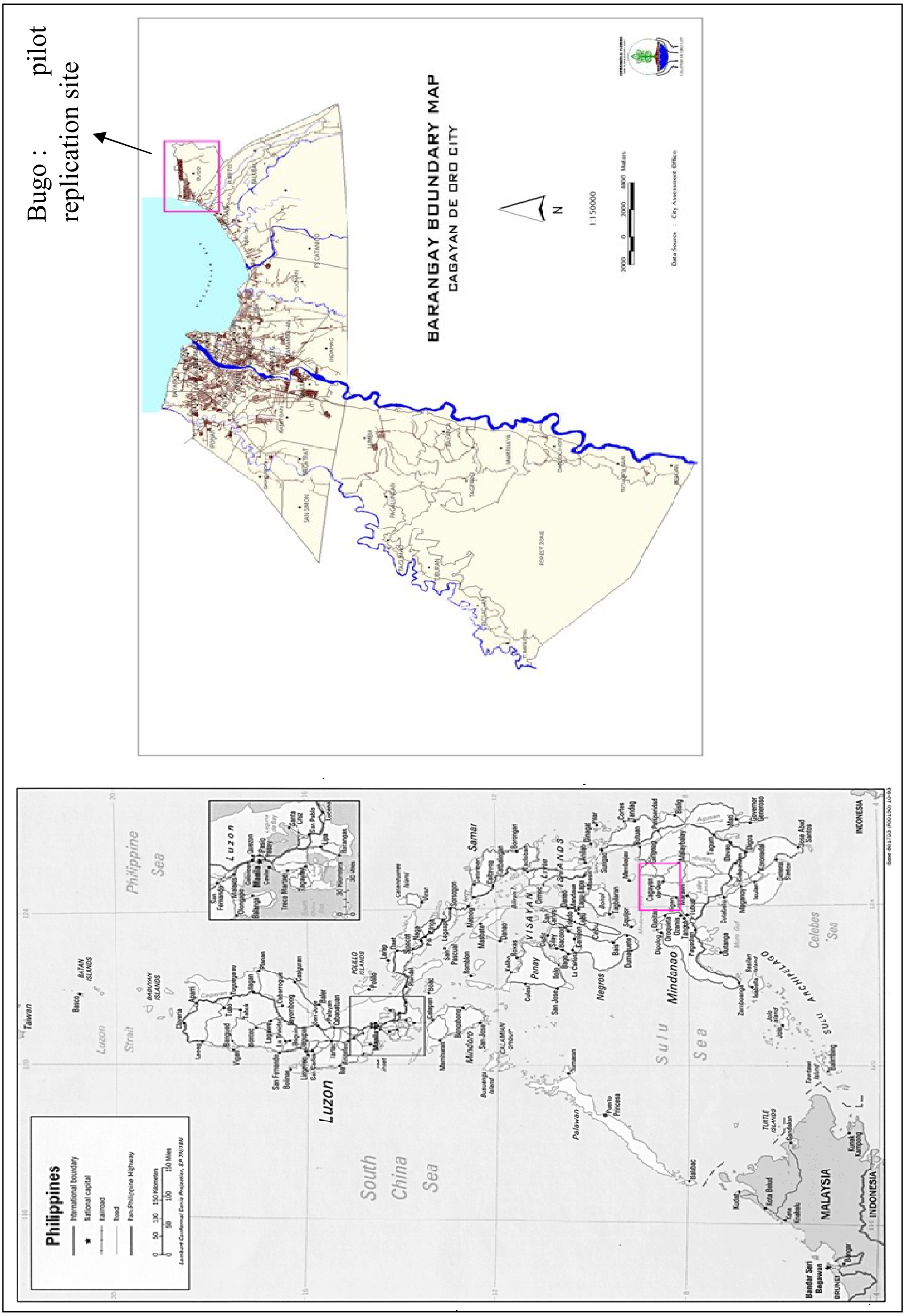

Figure 7.1a: Cagayan de Oro and Barangay Bugo location

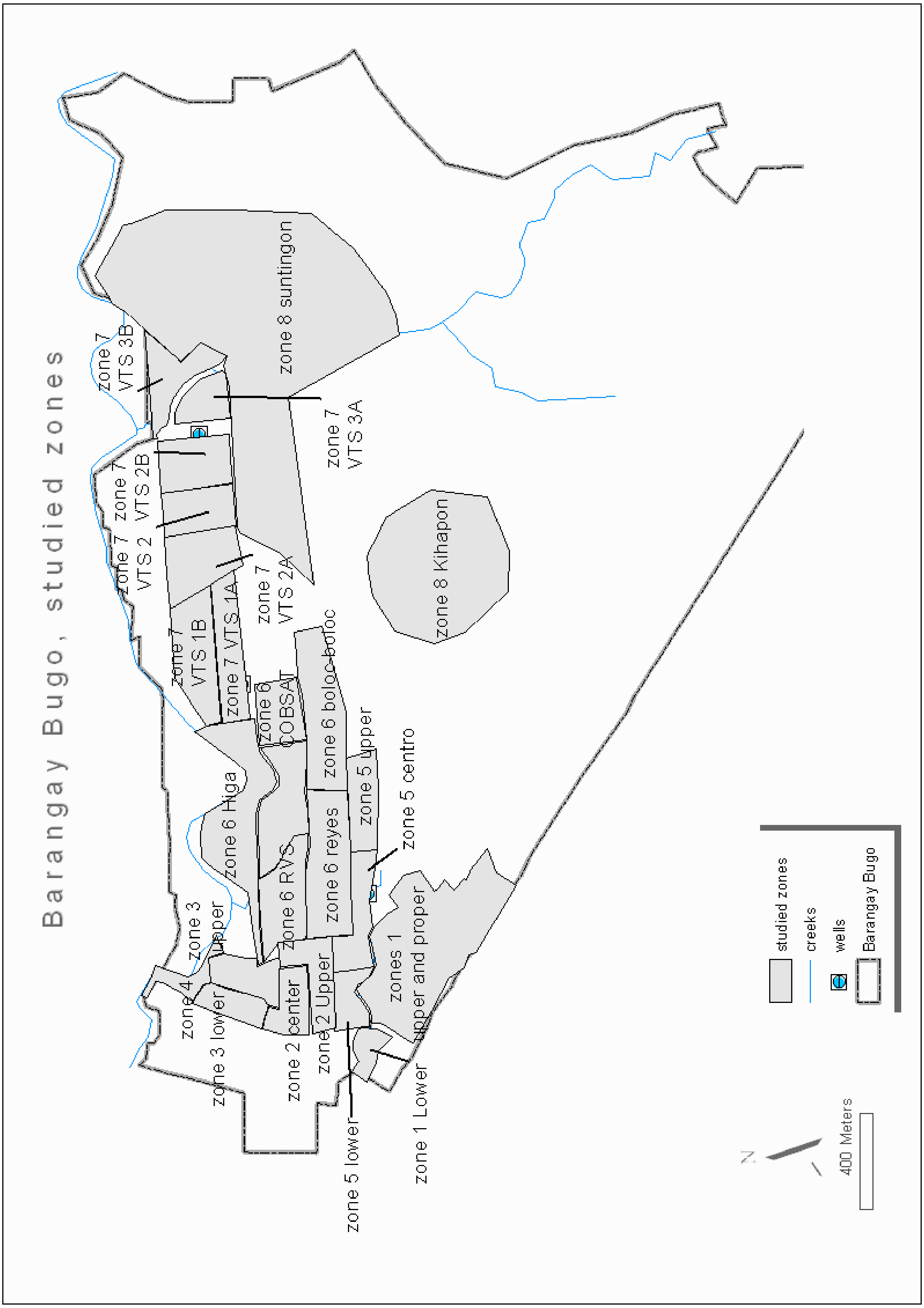

Figure 7.1b: Studied zones in the Barangay Bugo

44.7% of the surface of Cagayan de Oro is classified as agricultural land, while 38.4% is classified as open spaces. Only 2,276 ha are currently used for crop production, mainly located in the peri-urban barangays. Farm sizes average at 1.7 hectares, with about 0.5 ha being used for vegetable growing. The present productivity only comes to about 117g vegetables per capita per day. About 70% of the demand for fish is produced in the city. The two main reasons for this are: 1) the city is located right next to the sea (75% of the city is in a coastal area) 2) some urban farmers practice aquaculture. Backyard gardening is very common. About 40% of all households in the city have backyard gardens. The parent-child partnership in gardening is encouraged by the Department of Education Culture and Sports (DECS). The city's prospects for UA are great, mainly due to the availability of appropriate land. However, agricultural activities are still very fragmented.

All stakeholders would benefit from greater streamlining production. (www.ruaf.org/system/files?file=poster(cagayan).pdf)

7.2. Environment Social Community approach (ESC)

Suitability data coming from Bugo is very complete and weights attributed to each component are specific and come from the expert commission from PUVEP (PeriUrban Vegetable Project).

7.2.1. Suitability map

The suitability map was composed of three secondary maps:

Suitability index=soil map+water map+accessibility map

All the maps are combined with different weights.

7.2.1.1. Soil weighted map[1]

The soil map equation is :

Soil weighted= (0,7 * soil type + 0,3 * slope) * mask(pollution, landuse, flood, size, slope)

1) Soil classification

Elements of the equation are weighted according to type of soil or slope. The best fertile soil for UA has the highest weight.

1 (http://www.magsaysaymisor.gov.ph/index.php?cat1=3&cat2=1&cat3=9&PHPSESSID=b1c9f48de706d5ff2a4ea5bfba1f2c80) (Magcale-Macandog, Visco, Abucay, Ani, Tatlonghari, Garcia) (http://www.claveriamisor.gov.ph/index.php?option=content&task=view&id=40) (http://www.alubijid.gov.ph/index.php?cat1=2&cat2=3&cat3=5&PHPSESSID=7cf016bc4a47c4e11f9a7dc1113f373f)

Soil type	Weight
Bantog Clay	6
Jasaan Clay	6
Jasaan Clay, stony phase	4
Umingan clay loam	8

Table 7.1: Soil type classification

Giving the different attributed weights, the major part of the Barangay Bugo is extremely well classified in terms of soil. The northern part, where the studied zones are located obtains the highest value in terms of soil fertility and suitability for gardening.

2) Slope classification

In the case of the Barangay Bugo, six slope classes have been identified:

Slope	Weight
0-3%	100
3-6%	30
6-10%	10
10-15%	5
15-20%	2
>20%	1

Table 7.2: Slope classification

As Bugo is located besides Bohol Sea, the slope is very flat in the studied zones. Maximum slope is located in the middle part of Bugo, not studied in this research. However, small valleys are present in the northern part of Bugo and as specified by the classification, a difference of 3% intervenes for a weight divided by 3.

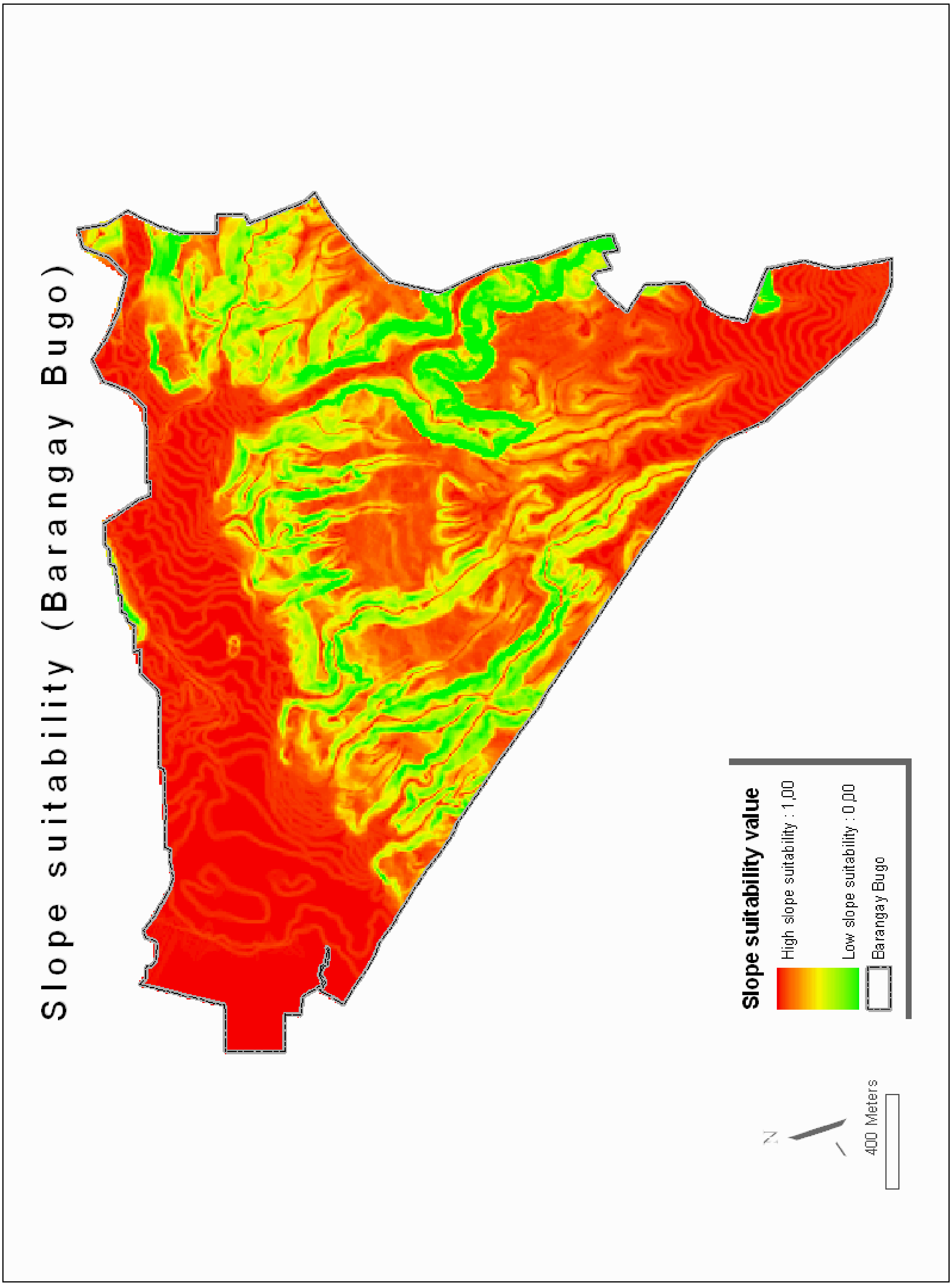

Figure 7.2: Suitability of slope (Barangay Bugo)

3) Mask for pollution, land use and plot size

Pollution zones have been identified by local communities such as rivers or plots polluted by garbage and must be excluded from the process. The plots classified as build up or covered land are masked, as only open lands are possible areas for research.

Moreover cells with flooding risks are also masked and finally, all plots under a surface of 400m² are masked. The allotment gardening group that identifies the smallest useful plot of land that can be used for one household imposes this condition.

4) Soil weighted map

The North of the Barangay seemed to be more suitable in terms of soil than the South (Figure 7.3).

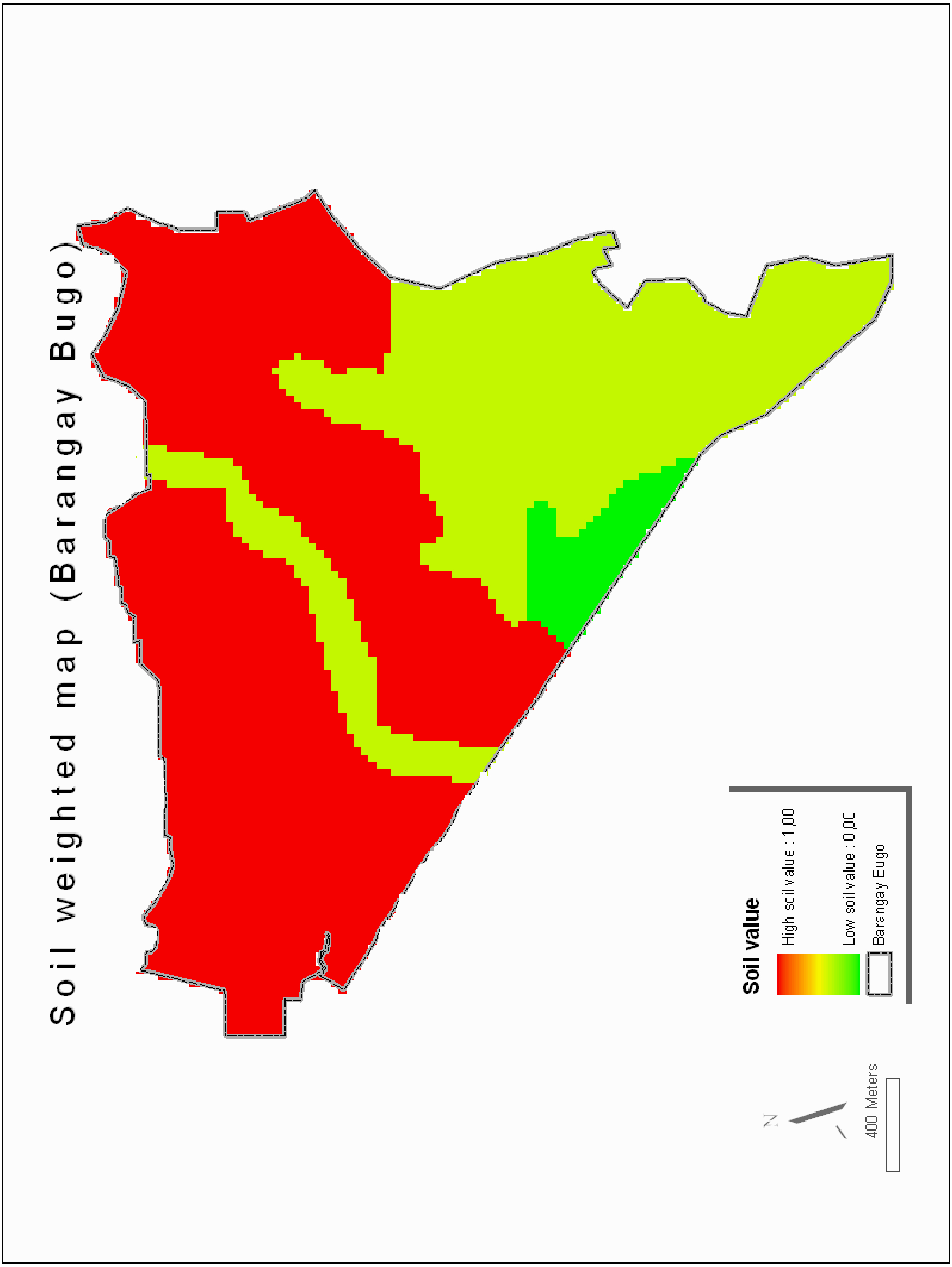

Figure 7.3: Soil weighted map (Barangay Bugo)

7.2.1.2. Water map

On the water map of Bugo, wells and creeks are considered as centroids.

Water = (0,4*water quality + 0,6 * water cost)

As water coming from wells and creeks has a different cost and different quality, experts give different weights to both water source. The reasons of the difference in quality are present during the dry season. The inhabitants of Bugo have the use to throw their garbage in the creeks. Therefore, rain is rare, stagnant water is really polluted.

At the opposite, water coming from wells has a good quality (current water) but is expensive for a use in irrigation.

In conclusion, during wet season, only water from creeks should be used and during dry season, only water from wells should be envisaged.

Water source	Weight for quality	Weight for cost
Well	10	5
Creek	7	10

Table 7.3: Water quality and cost

The water map was established through an Inverse Distance Weighted method.

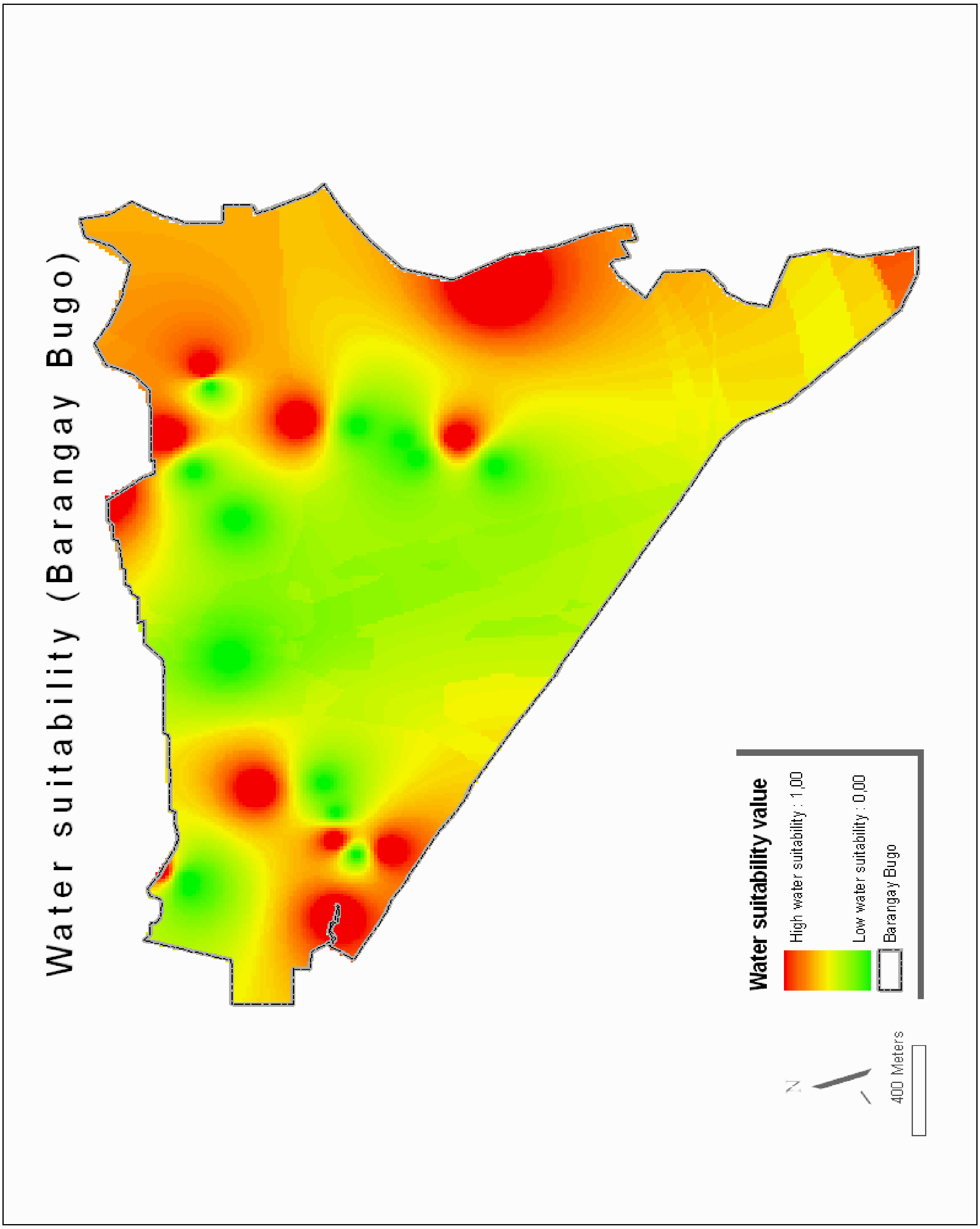

Figure 7.4: Water suitability map (Inverse Distance Weighted method) (Barangay Bugo)

The water map might be divided into two well-deserved zones, the east part and the west part of Bugo. The creeks influenced positively the water map.

7.2.1.3. Accessibility map

The accessibility theme only considered the distance from plots to other elements such as roads, houses or water, as gardeners have to walk between plots and water points by the way of a road (figure 7.5). The equation for the accessibility map gave less power to access to roads because Filipinos prefer to use the eskinitas.

Accessibility index = (0,4 * houses + 0,2 * roads + 0,4 * water)

Distance to Houses	Weight
0-10m	3000
10-50m	1000
50-100m	500
100-200m	200
200-500m	100
500-1000m	60
1000-2000m	40
2000-5000m	20

Table 7.4: Weighted distances from houses

Distance to water	Weight
0-10m	300
10-20m	150
20-50m	100
50-100m	60
100-200m	30
200-500m	10

Table 7.5: Weighted distance from water points

Distance to roads	Weight
0-10m	500
10-20m	200
20-50m	100
50-100m	60
100-500m	30
500-1000m	10
>1000m	No data

Table 7.6: Weighted distance from roads

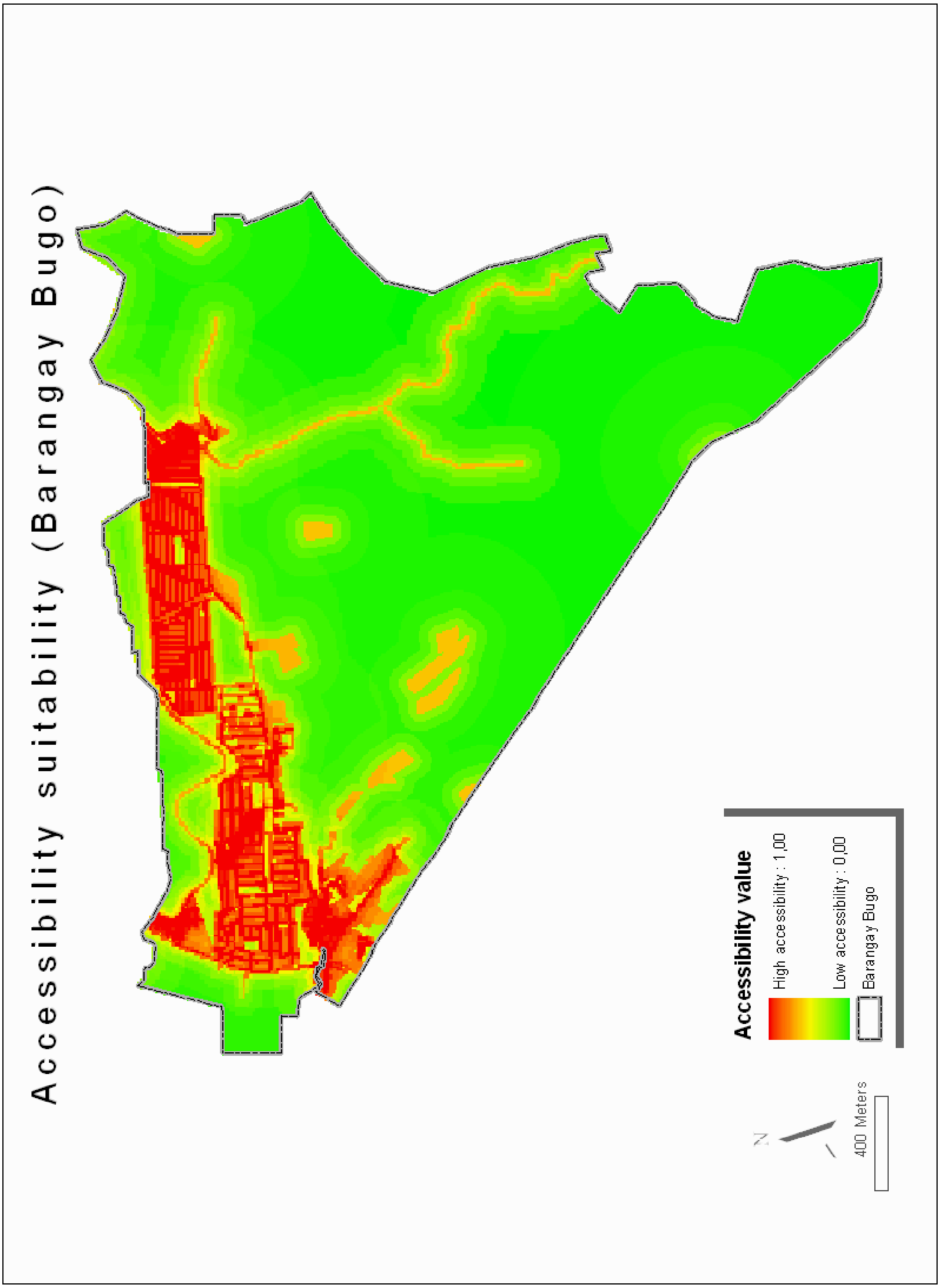

Figure 7.5: Accessibility map (Barangay Bugo)

As the northern part was classified as residential, the accessibility value w as very important due to the location of all the barangay's houses. A smaller value, indicated by a yellow color, was due to the presence of creeks.

Small rectangular patches classified as residential had a mean value of accessibility due to their distance from any accessibility element such as roads.

7.2.1.4. Output: Suitability map

The combination between soil, water and accessibility produced a map with globally adequate values in terms of UA implementation in the northern part of the Barangay and inadequate values in the south for UA (Figure 7.6). The excluded zones or the mask, are the built-up areas as specified by the experts which indicate that gardening is not possible within these zones.

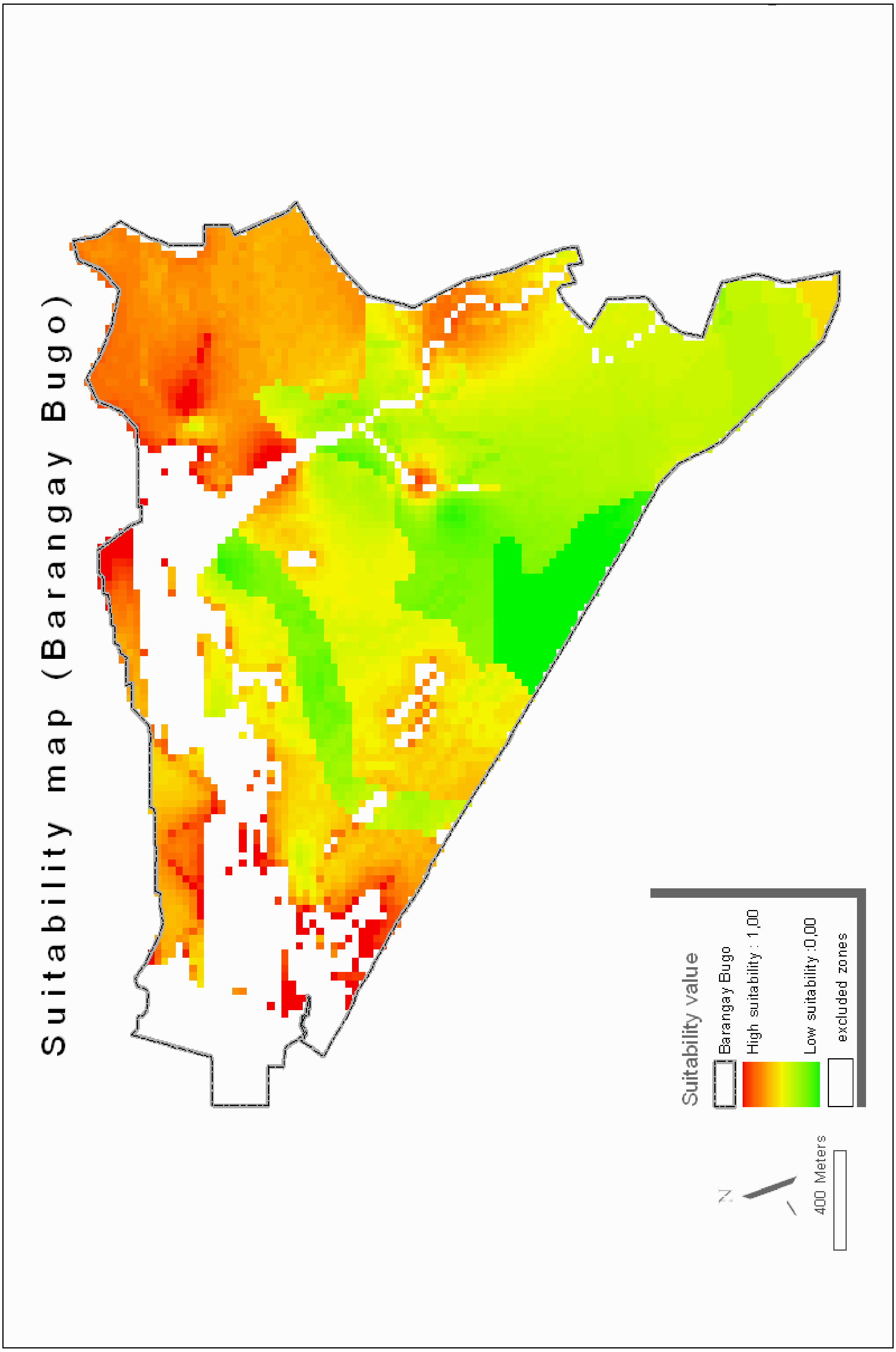

Figure 7.6: Suitability map (Barangay Bugo)

The eastern part of the barangay obtained a high suitability value indicating that a plot located in this zone will probably have no environmental problems. The main result was that suitable environmental zones are located just near houses; this infers that suitable plots for UA should be located at a short distance from residential lots.

7.2.2. Social map

In order to give a social indicator to all the studied zones in Bugo, a social survey has been implemented (Appendix 10). Moreover, some local meetings with the chiefs of zones have been implemented. Unfortunately, some zones were not included in the process: zone 7 VTS 1B, 1A, 2, 2B, zone 2 centre, zone 2 upper and zone 1 lower (Figure 7.1).

7.2.2.1. Survey-Based Indicator (SBI)

In the social survey, some variables were studied with different attributed weights in order to compute a Survey-Based-Indicator:

Variables	Weight
income household size (ID)	60
skills Allotment Gardening or SWM awareness	30
Garbage practices	10

Table 7.7: Variables weights for the social survey based map

The Survey-based Indicator was computed through this equation:

SBI=60*Income People Density+30*(Skills*Awareness)+10*Garbage Practice

Local people attributed a high weight to Income Density as this is one of the most influent factors in poverty for the Barangay but also for most of the developing countries. People are not yet aware about the benefits of good garbage segregation but they manifest an interest about. This explains the weight of 30 for Skills and Awareness and the low weight for garbage practices.

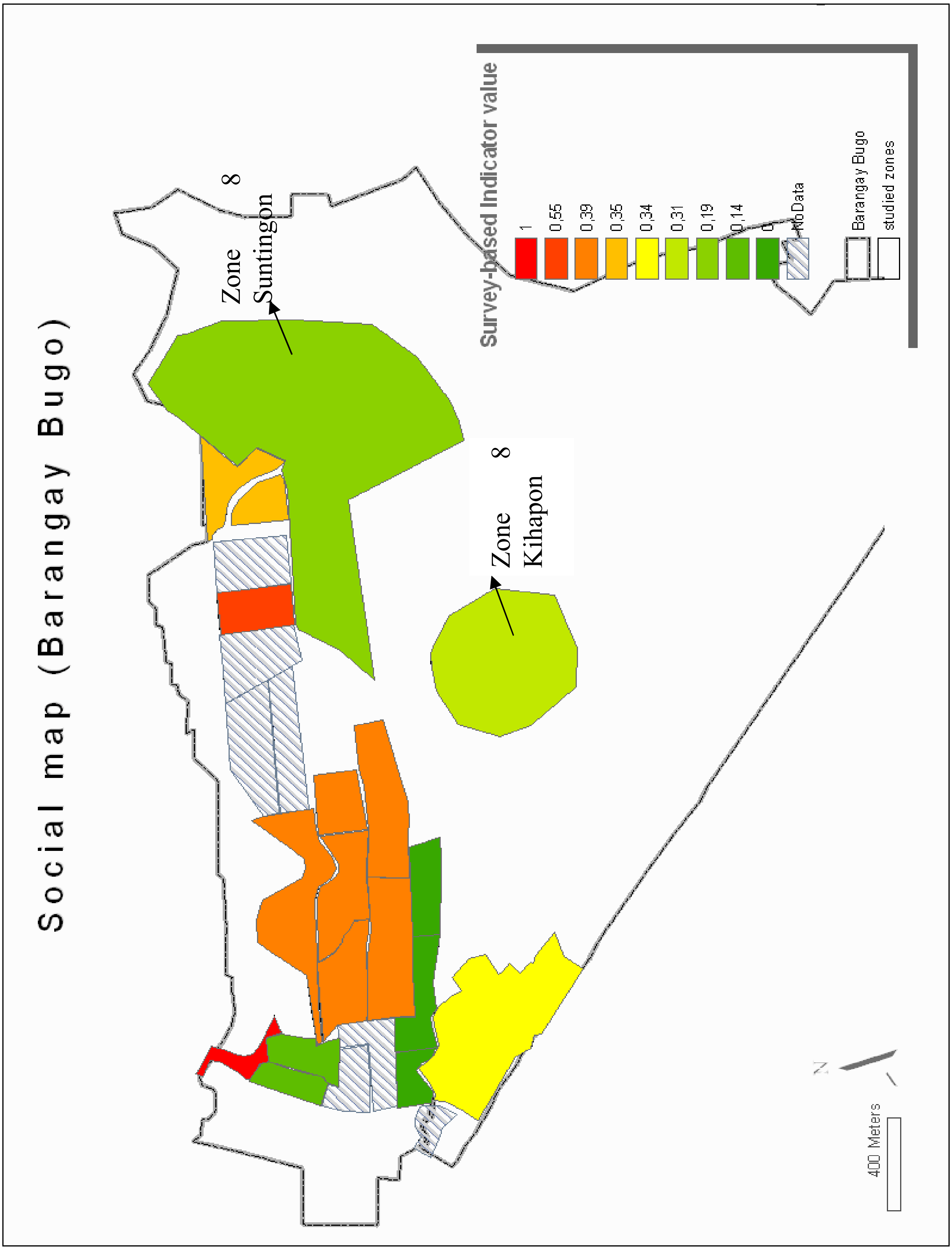

Figure 7.7: Social map (Barangay Bugo)

Zone 8 Suntingon and Kihapon obtained the lowest Survey-Based Indicator. These zones are the poorest with a high density; therefore, the Income-Density indicator is very high. These zones are very specific as they are composed of many squatters living in the forest. They are not very well known by local experts but it seems that they are not motivated by any SWM projects, which is why their awareness about SWM is very low compared to other zones.

The skills of the community were evaluated based on their main occupation. Twenty-three jobs are present in the zones with high weighted jobs such as teachers and farmers in zone 4.

Moreover, Garbage Practices were computed based on materials used for garbage collection. If people prefer to throw garbage on the seashore rather than put it in a returnable sack, a low weight will be awarded to the community as in zone 1 upper.

As the suitability map covered all the Barangay Bugo, a form of data extrapolation is required in order to avoid the exclusion of potential allotment gardens outside the surveyed zones. The Inverse Distance Weighted was chosen in the same way as the experiment in Bacolod (Figure 7.8). The lowest value of SBI will be assigned to the farthest location while the highest will be assigned to the closest location.

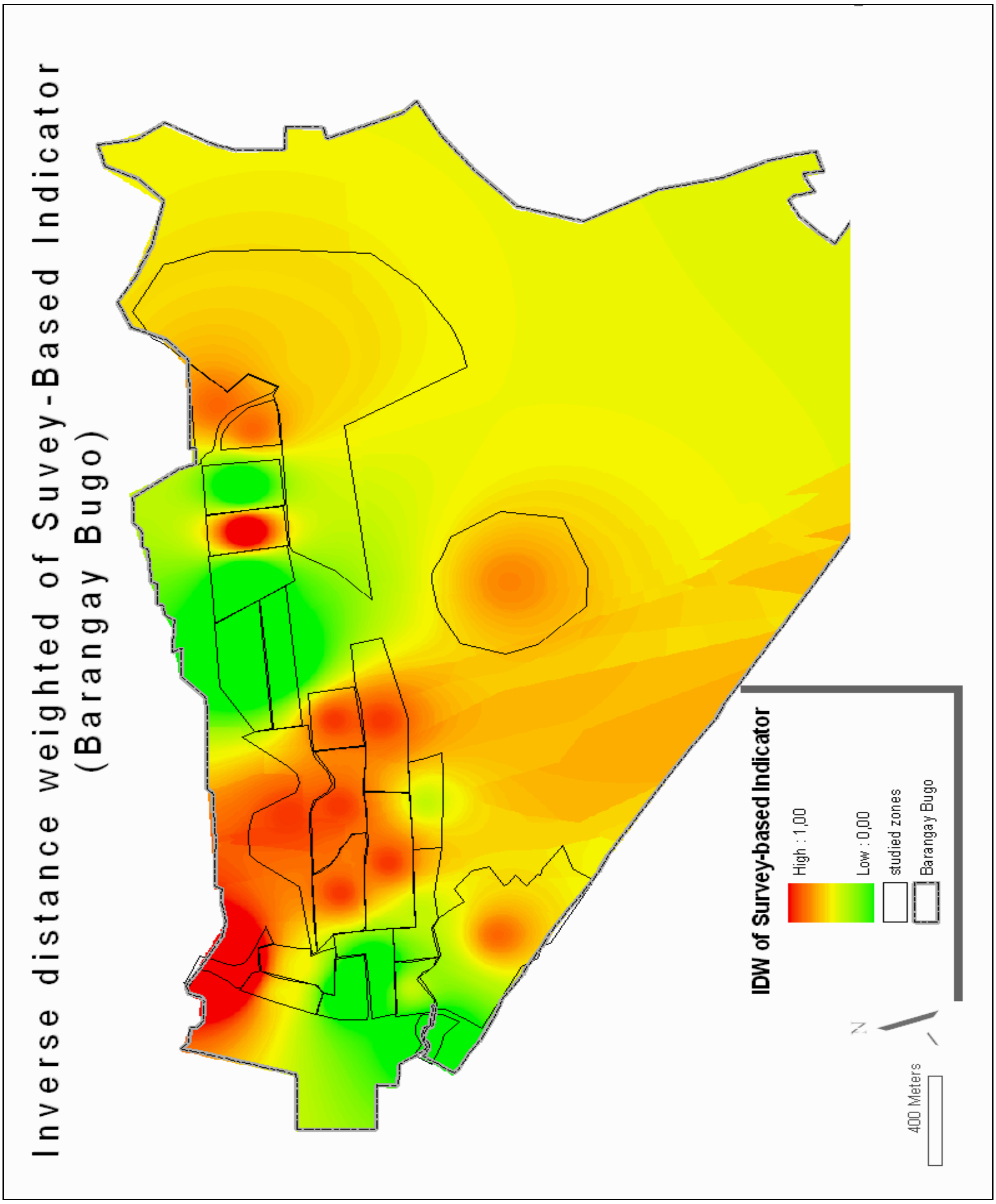

Figure 7.8: Inverse Distance Weighted of SBI (Barangay Bugo)

The centroids of each surveyed zone are visible on the map. Since no data was available for the southern part of Bugo, low values are present. Nevertheless, this is not the lowest value due to the presence of zone 8 Kihapon. The green values are the result of an absence of data for various zones, therefore only the interpolation from surveyed zones provides a value.

7.2.3. Community-based map

As in Bacolod, the community has attributed weights to several domains of the Community map:
A community activity has received training only in the zone Villa Trinitas Phase 3. Phase Three is located uphill. It has a creek that channels water from the highlands. Eventually, the creek becomes a dumping site. On rainy days, the trash rises up as the water rushes down the mountains. The residents do not have any concerns regarding the consequences of their irresponsible garbage disposal. The clogged creek caused eight houses to float on one day of flooding (http://www.dilg.gov.ph/blgd/lepm%20links/bp_Bugo.htm).

Features	Weight
UA	30
SWM	20
Territory Management	15
Social Development	10
Religious Features	10
Leisure	5
Other (mall, markets,…)	10

Table 7.8: Features weights for the community-based map

This community map (Figure 7.9) shows many high weighted features such as compost barrels or allotment gardens that are very important in the context of this research. Many elements that, according to the communities are useful, are present on the Community map, therefore, the Density of Indicator is very high (Figure 7.10).

As seen on the figure (Figure 7.9), some elements are covering the zone 8 Suntingon. During the community mapping activity in Villa Trinitas Phase 3, some people from zone 8 were frustrated at not being included in the process and presented elements that were crucial to them, such as a piggery or the water springs. These elements have been included as this is the community who presented them.

As the community map covered only a small part of the studied zones, Villa Trinitas Phase3, a combination with a social-survey was compulsory in order to give a social value to all zones of the barangay Bugo.

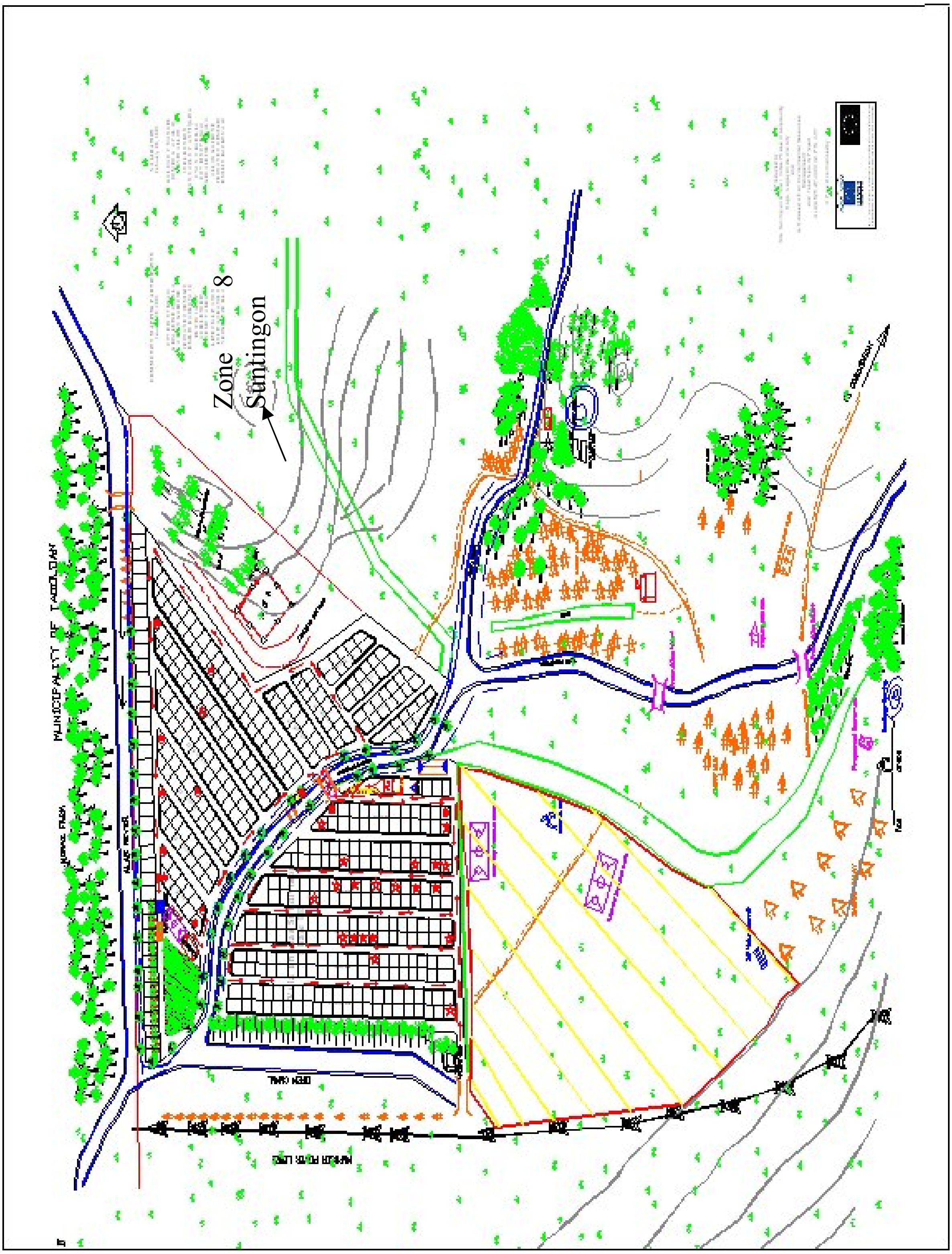

Figure 7.9: Community map of Villa Trinitas Phase 3 (Barangay Bugo)

Figure 7.10: Community-based map (Barangay Bugo,Villa Trinitas Phase 3)

7.2.4. Social community based map

As only Villa Trinitas Phase 3 has an accurate Community map and the SBI was computed for the all zones, a calibrated social-community based map was proposed. In Villa Trinitas Phase 3, the social value is the mean between the social survey and community map; the rest of the social map is only composed of the SBI value.

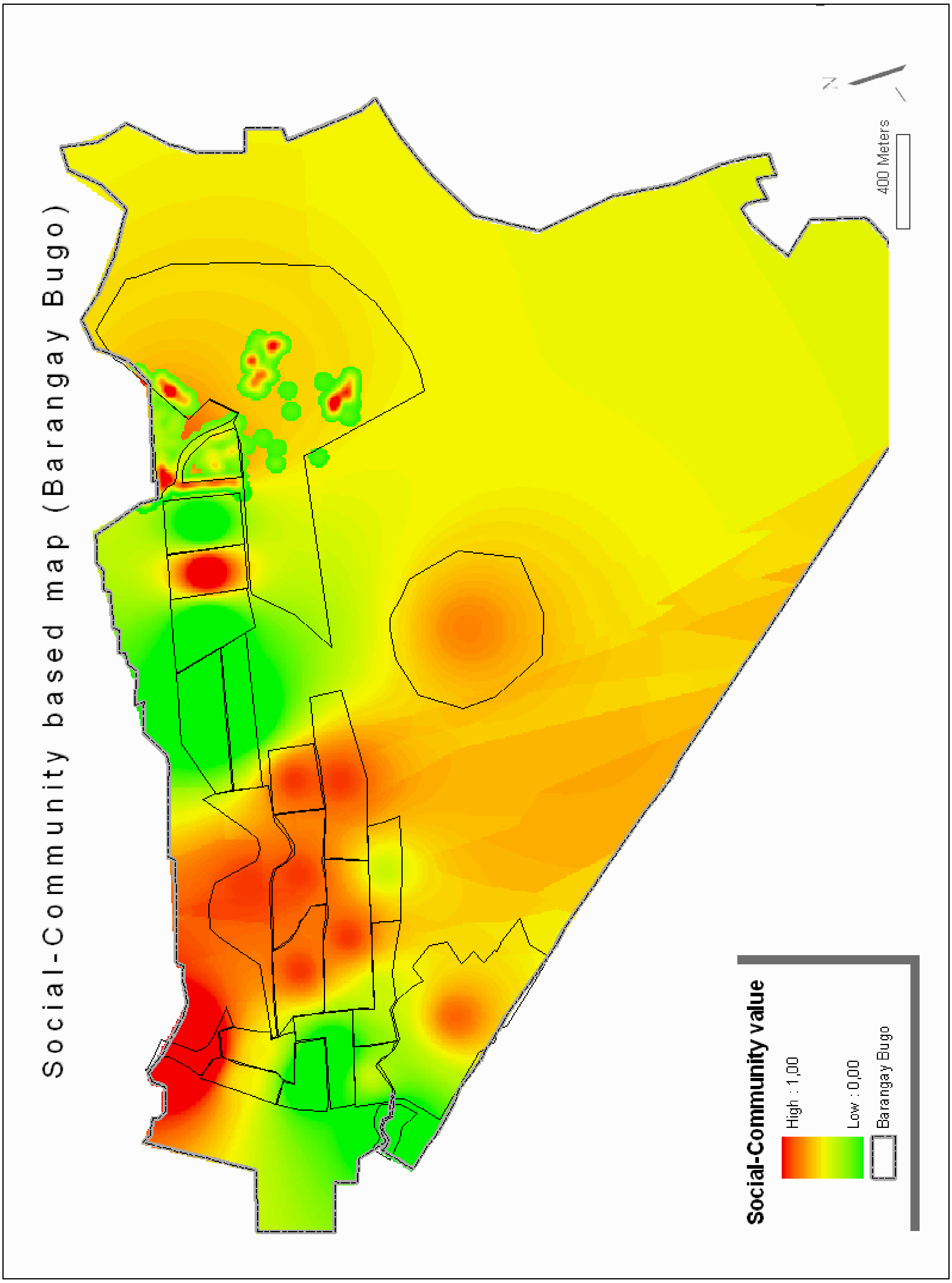

Figure 7.11: Social-Community based map (Barangay Bugo)

With this combination, differences were visible only for Villa Trinitas as available information is more accurate, as the mapped information as a point shape.

If no community map had been available, all Villa Trinitas would have high social value. With the addition of community mapping information, some points have high value due to their extreme importance on the community map and where the community mapped no information; this is not a low value, as in the Community-based map, but a mean or high value due to the influence of the survey-based map.

The conclusion on the social-community based map is that globally the information on villa Trinitas is at the same time, more accurate and enhanced by the addition of the Community map.

7.2.5. Output : Environment Survey Community map

In order to compare the results between Barangay 7 and Bugo, the same combinations have been used in Bugo as in Barangay 7
Three possible combinations have been used between the suitability map and the social community-based map. As in Barangay 7, the first scenario (a, the neutral one) is a combination with equal weight attributed to all the maps. The second scenario (b, environmental) gives 90% to environmental data, and the third scenario (c, social) gives 90% to community data.

Approach	Scenario	Combinations
ESC	a (neutral)	50/100 suitability map+ 50/100 (social community based map)
	b (environmental)	90/100 Suitability map + 10/100 Social Community based map
	c (social)	10/100 Suitability map + 90/100 Social Community based map

Table 7.9: Combinations ESC

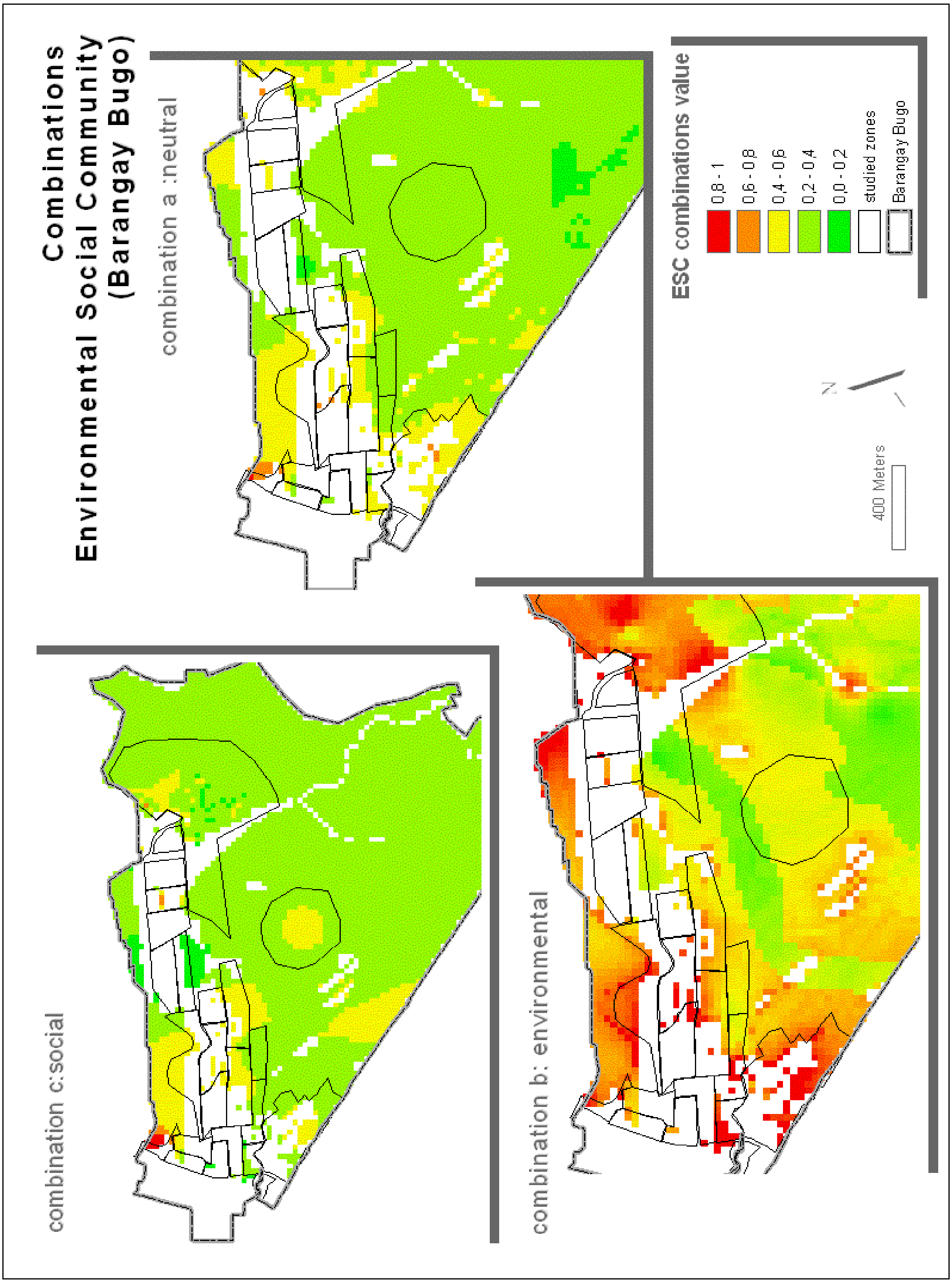

Figure 7.12: Environment Social Community Combinations (Barangay Bugo)

Only small plots were identified as adequate for gardening with the neutral and social scenarios. The west part of Bugo seemed to be more adequate for UA. Moreover, comparing from the ‘social scenario’ (c) to the ‘neutral scenario’ (a), a larger values panel was present meaning that if a landowner did not agree to rent its land, another zone was suitable; more options are offered.

On the environmental scenario (b), more zones, compared to the two other combinations, are identified as suitable for allotment gardening and SWM as in the pilot case. Moreover, even plots located far away from residential lots were identified as potential candidates for gardening meaning that environment and social priority are in opposition. People give priority to zones far from their houses as environment is adequate.

Whatever the chosen scenario, the South of the Barangay seemed to be not adequate in terms of UA and SWM. This could be due to the lack of information from several maps such as Community or Social maps.

Due to the mask application (house, water: see 7.2.1.4), it was difficult to really evaluate the potentiality of studied zones in terms of UA.

7.3. Statistical Spatial Index approach (SSI)

7.3.1. Statistical map

The second approach starts with a PCA applied to social data (Appendix 11). This data is largely the same as for the social survey except that the number of children has been added.

Data was only available for 9 zones and 8 variables. A simulation of new individuals was therefore compulsory in order to be statistically robust. Five sub-zones per real zones have been simulated in order to obtain 54 individuals.

Variable	Justification of Use
Number of household	Estimation of working capacity
population	Estimation of the density
ratio of employment	Estimation of job security
aware of AG	Estimation of the awareness about AG and SWM
aware of ISWM	
income per month	Estimation of the poverty situation
number of children	Estimation of the time dedicated to

	UA
skills	Estimation of the skills about UA and SWM

Table 7.10: Variables of the PCA and justification of use

With the two first components, 64% of the variability is explained.

	F1	F2
Eigen values	2.851	2.259
Variability (%)	35.636	28.232
% cumulated	35.636	63.867

Table 7.11: Eigen values

	F1	F2
No. of household	0.924	0.065
population	0.897	-0.005
ratio of employment	-0.125	0.672
aware of AG	-0.524	0.264
aware of ISWM	0.229	0.838
income per month	0.219	0.675
number of children	0.879	-0.049
skills	0.172	-0.756

Table 7.12: Correlation between variables and factors

According to table 7.11 and the high correlation between ‘number of households’ variables and ‘population’, the first principal component may represent a concept of large population size The second component represents the population who is aware of SWM but not really skilled about it.

Therefore, according to the general objective of the research, the quadrant defined by F1 positive and F2 positive is in accordance with priority targets of the current research. Nevertheless, zones with low coordinates in F1 negative and high coordinates in F2 positive have the same importance as zones with low positive coordinates in F1 and high coordinates in F2 positive. The second quadrant is therefore defined by F1 negative and F2 positive. The last quadrant is defined by large population size without any SWM motivation, but any zones are present in the fourth quadrant.

Therefore, according to these priorities, each positive and negative factor has a specific weight defined according to the general objectives of prioritising the poor but SWM and UA motivated com *Community-based GIS – Bacolod City, Philippines* munity :

Factors	Weights
F1 positive	95
F1 negative	66
F2 positive	99
F2 negative	70

Table 7.13: Weights attributed to factor

Compared to the weights attributed in Bacolod, due to the different signification of the axes, different weights have been attributed. These give higher importance to a large population size (Replication case) than to a population composed of squatters with a low education level which practices composting (Pilot case).

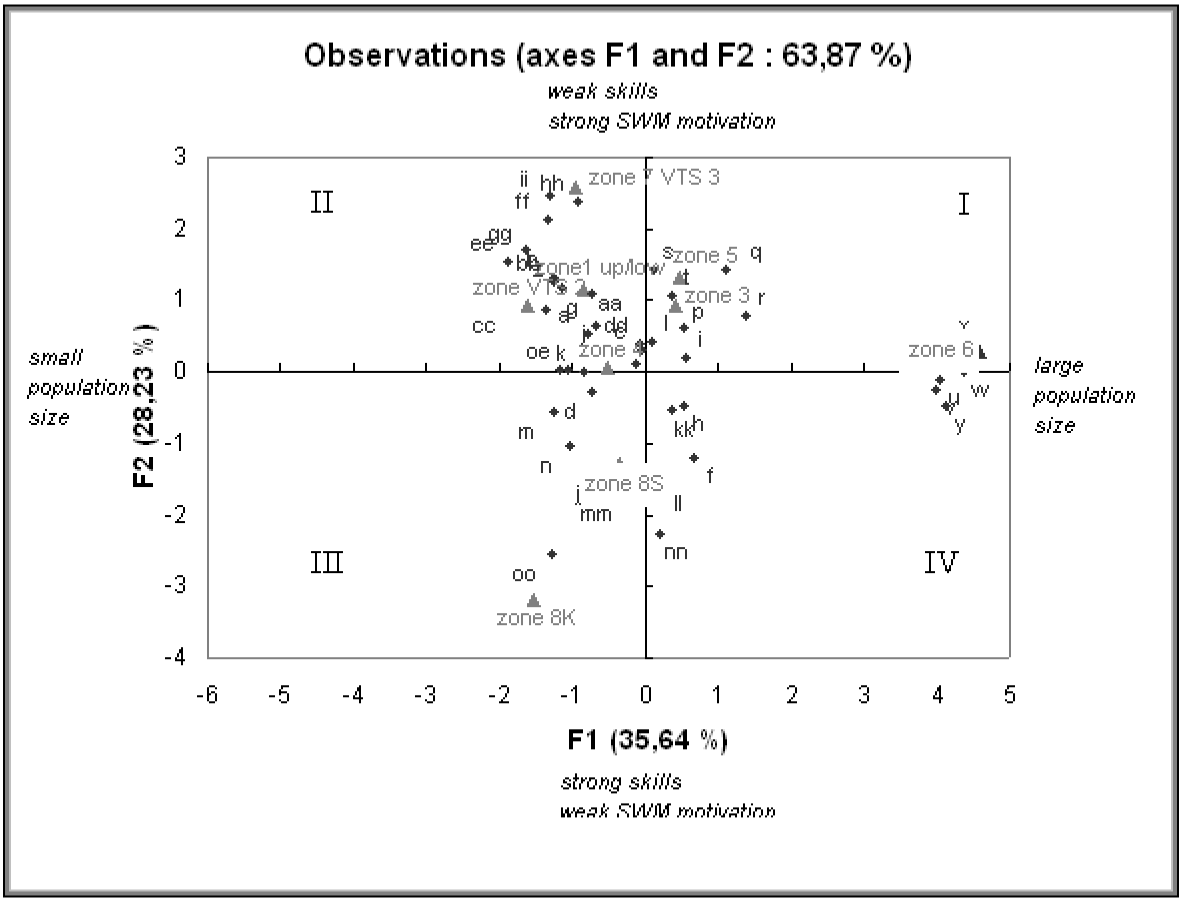

Figure 7.13: Representation of the individuals in the F1/F2 plan

Zones	F1	F2	weighted combination	normalization
zone 1 upper & proper	-0.839	1.164	59.84	0.49
zone 3	0.417	0.915	130.24	0.58
zone 4	-0.514	0.065	-27.51	0.38
zone 5	0.466	1.317	174.71	0.63
zone 6	4.587	0.285	463.95	1
zone VTS 2	-1.613	0.936	-13.83	0.39
zone VTS 3	-0.954	2.593	193.75	0.66
zone 8 Suntingon	-0.361	-1.272	-112.86	0.27
zone 8 Kihapon	-1.530	-3.189	-324.18	0

Table 7.14: Observations coordinates

According to these defined weights, zone 6 came out best, followed immediately by Villa Trinitas Phase 3 and zone 5. This is the same classification as in the social survey map. Both zones 8 are the less prioritized as their motivation for SWM is weak and this is a small population.

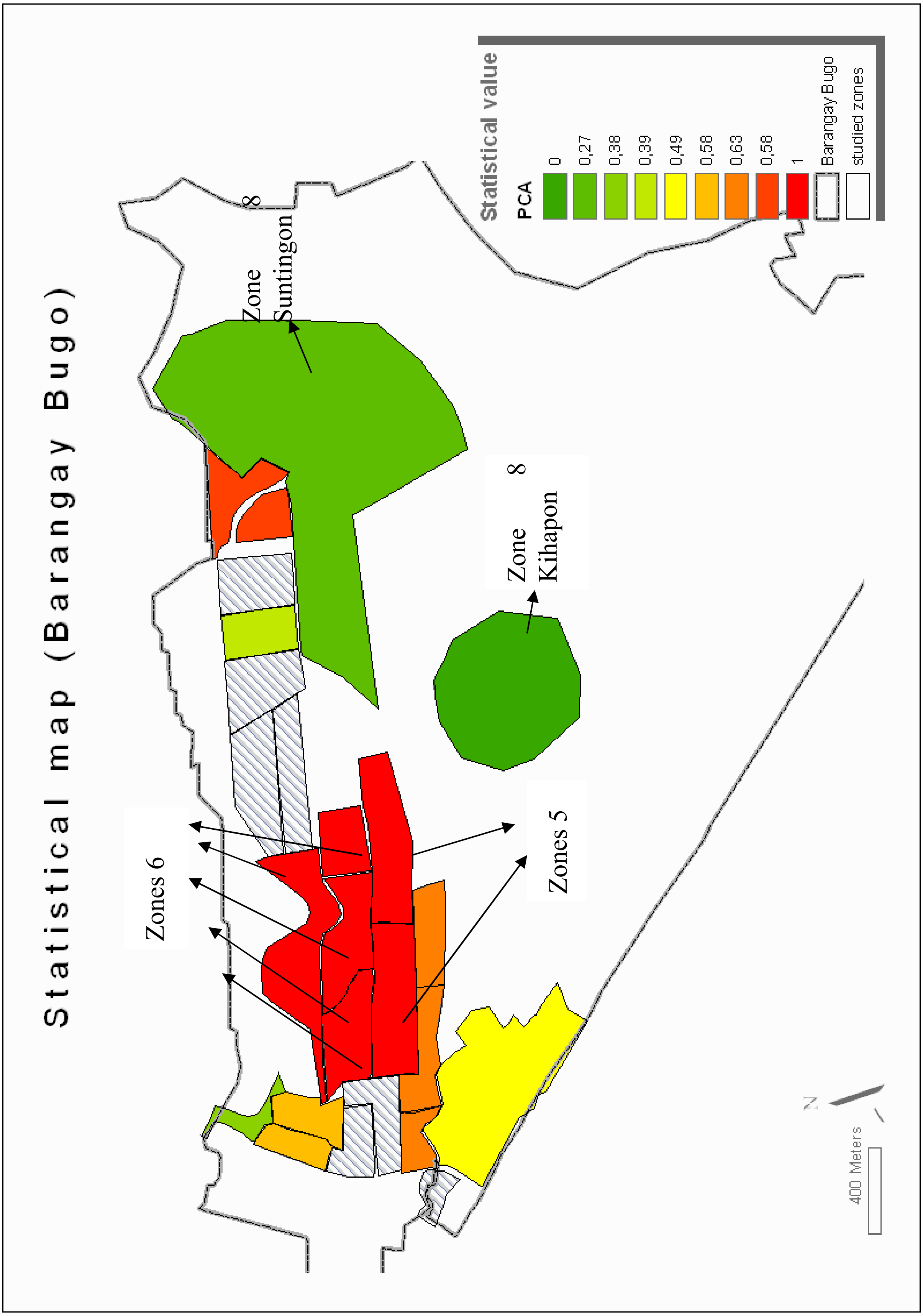

Figure 7.14: Statistical map (Barangay Bugo)

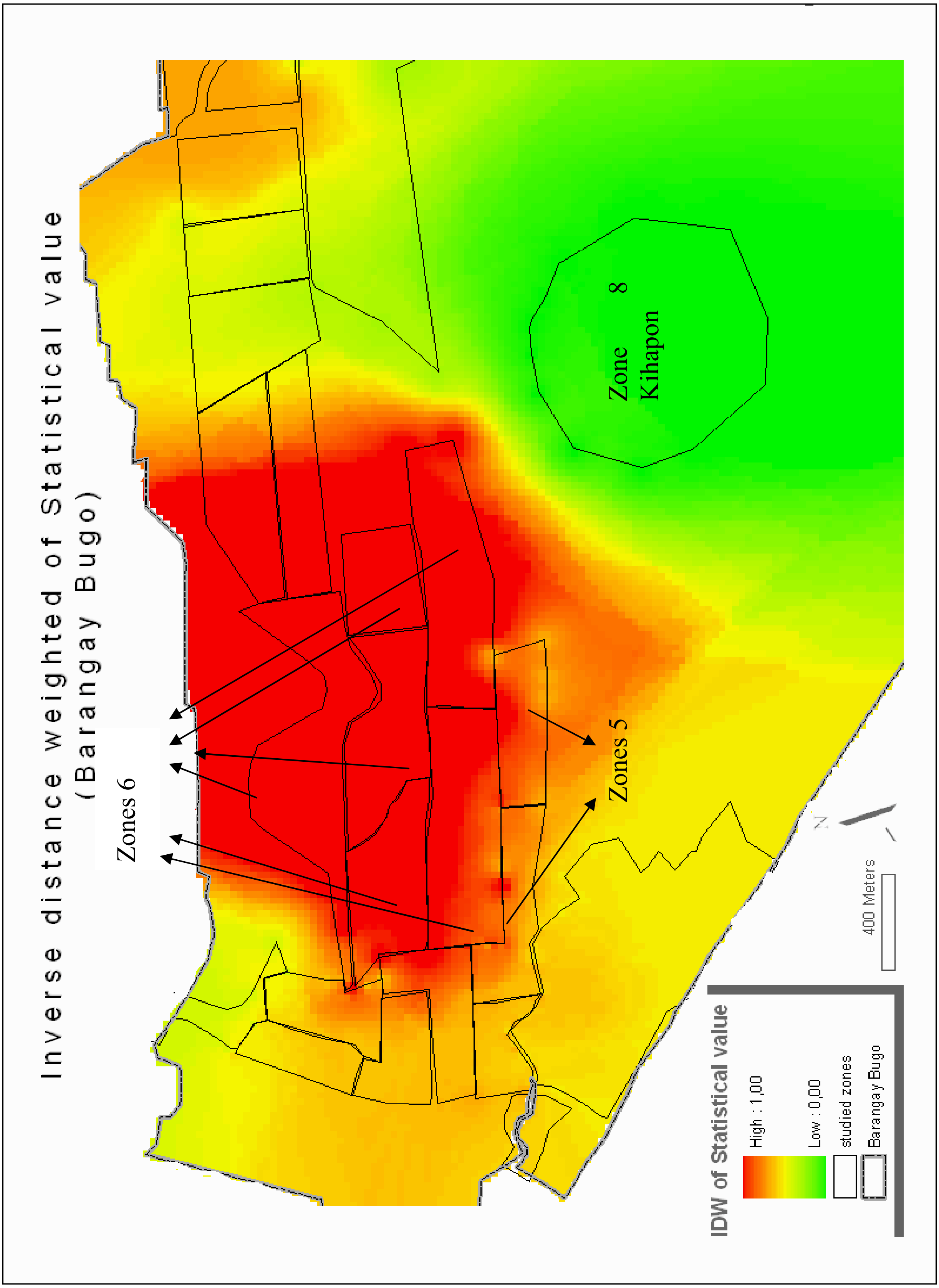

Figure 7.15: Inverse Distance Weighted of Statistical value (Barangay Bugo)

As not all the zones have been surveyed the output values of the PCA were extrapolated by Inverse Distance Weighted, the centre of all studied zones obtains the highest value due to the influence of well classified zones 6. A remark must be made concerning zone 8 Suntingon that is not the worst in terms of the social targets of the research due to the extrapolation of the good value of the zone Villa Trinitas Phase 3.

7.3.2. Spatial Index map

7.3.2.1. Classification

An unsupervised classification is operated on the Spot Image dating from 2005 of Cagayan de Oro with the ISODATA algorithm (Figure 7.16). Because of this operation, 6 classes have been identified: water, vegetation type 1, vegetation type 2, urban, arable land, clouds.

The choice of a simple unsupervised classification is due to the mean spatial resolution of the image and the lack of ground-truth validation data.

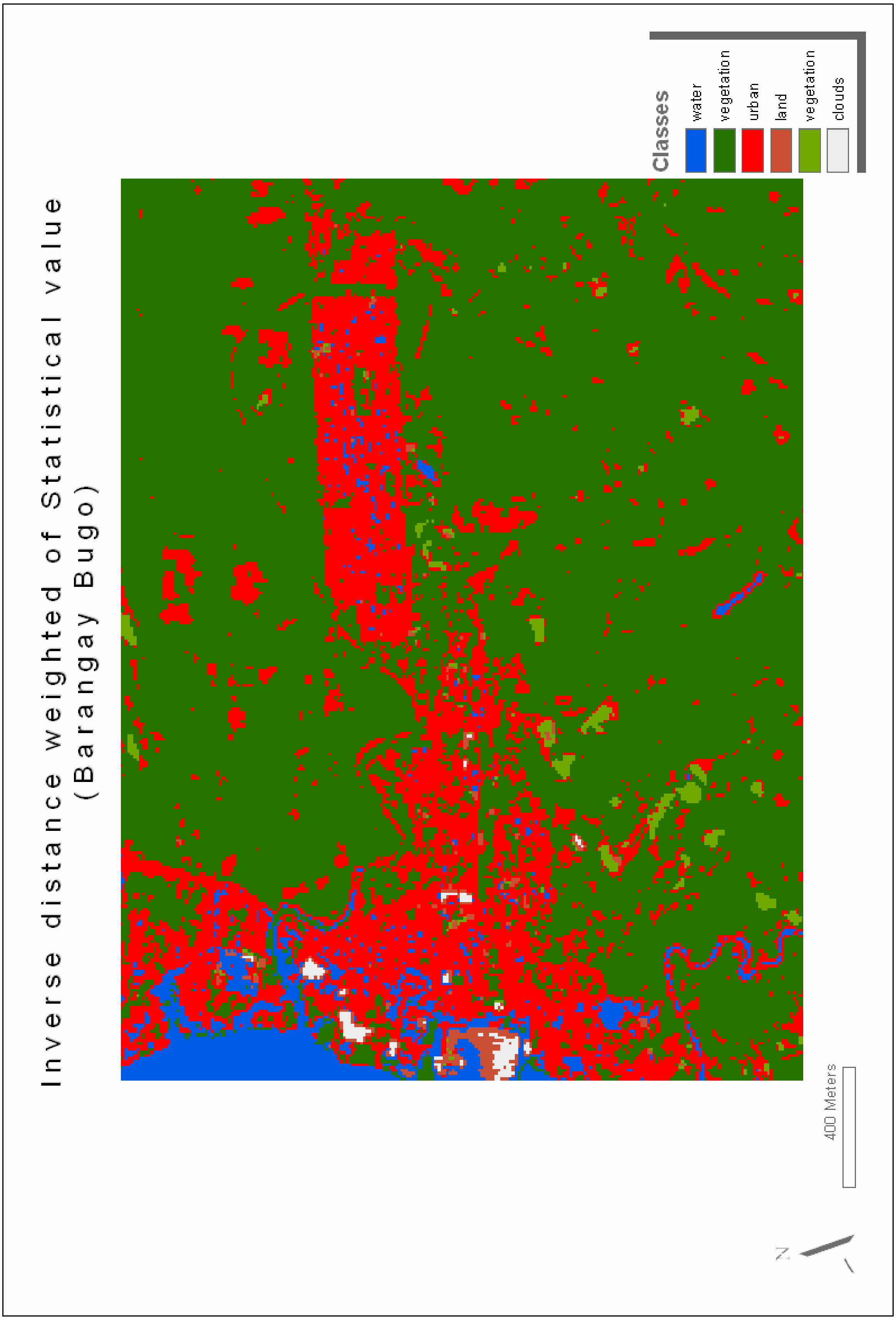

Figure 7.16: Unsupervised classification (Barangay Bugo and surroundings)

7.3.2.2. Mean Shape Index map

Concerning the landscape, the mean shape index was calculated on the house classes. The index was computed based on small aggregates of classified pixels. Compared to Bacolod, the situation is quite different due to the different type of classification. It was not possible to identify gardens on the classification in Bugo, therefore, the working assumptions concerning garden was dropped. The Spatial Index map was only composed of the extrapolation of MSI.

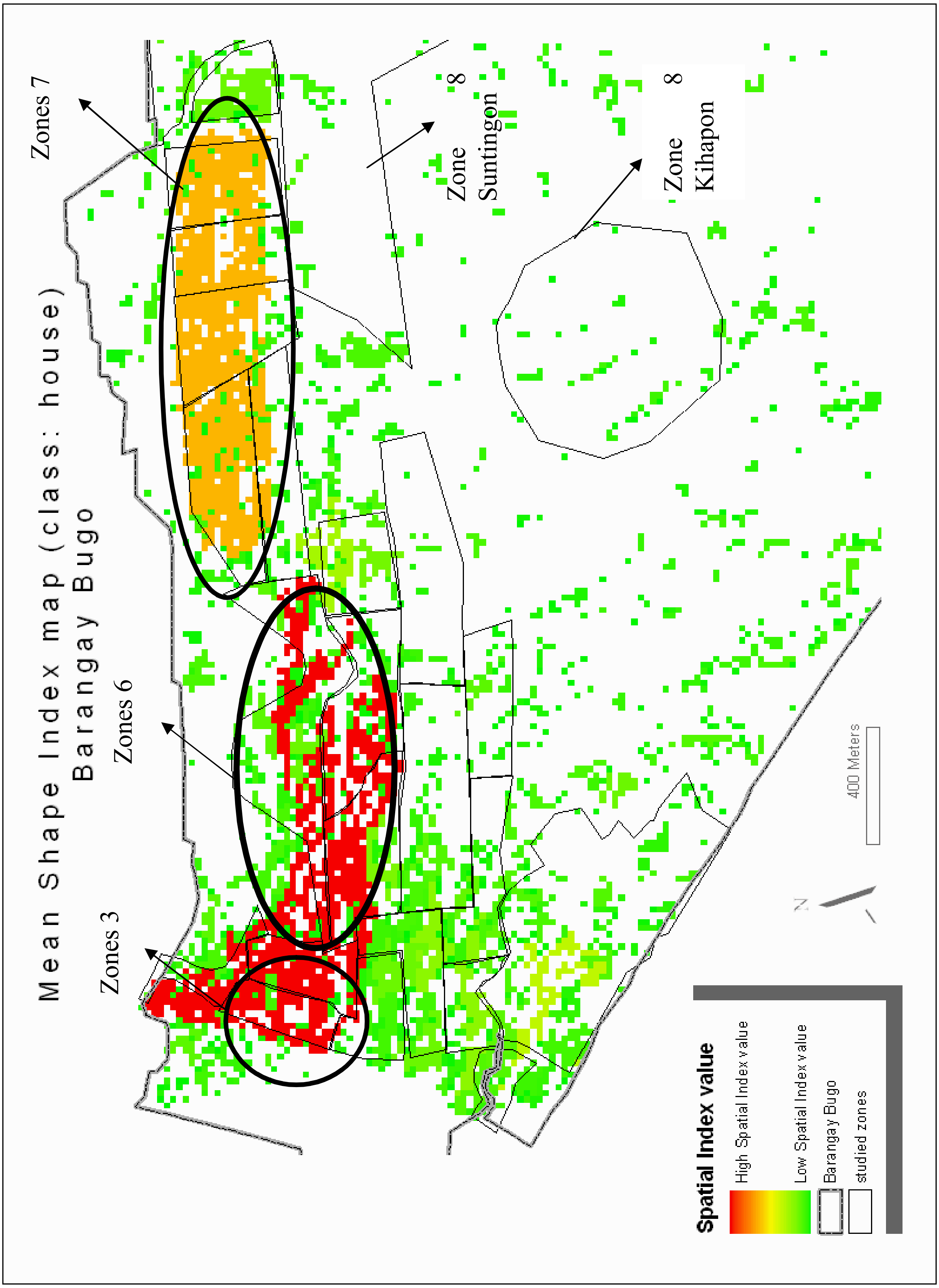

Figure 7.17: Mean Shape Index map (Barangay Bugo)

Globally, all the zones 3, 6 and 7 obtained a high MSI value. Nevertheless, most of the houses identified in the Barangay Bugo were irregular. The zones 8 obtained the lowest values of MSI which identified rich zones which leads to a poor social discrimination on the basis of the image classification. In fact, this may be correlated to the specific location of the zones. It is quite difficult to locate houses in these zones as there are squatters living in forest and misclassified. Therefore, in the discussion after validation it should be realistic to take zones 8 into the process.

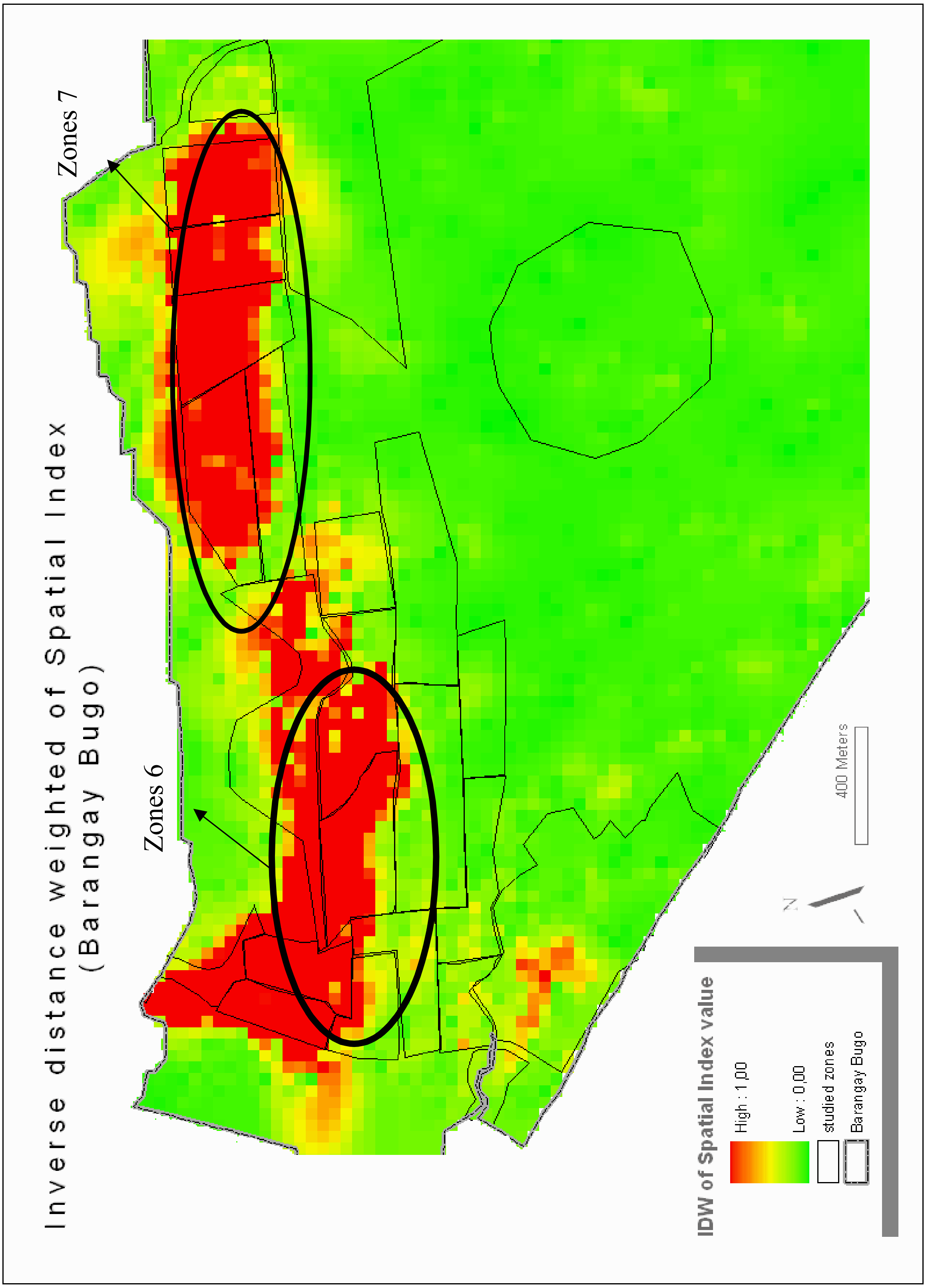

Figure 7.18: IDW of the Spatial Index value (Barangay Bugo)

With the extrapolation of the Mean Shape Index through the IDW method, the north of zones 6 is irregular and zones 7, except Villa Trinitas Phase 3, also. These zones were therefore considered as poor according to the working assumptions with spatial index and have to be prioritized for UA.
The case of zones 8 must be highlighted as these zones are known as squatter areas but due to the forest cover of the zones and therefore errors in the classification, it is difficult to identify any house pixels.

7.3.3. Output Statistical Spatial Index map

As before, 3 simulations were computed. Firstly, the same weights were attributed to statistical map as to spatial index map. Secondly, 90% were attributed to the environmental side of the combination, the Spatial Index map. Thirdly, only 10% were attributed to the environmental aspect.

Approach	Scenario	Combinations
SSI	a (neutral)	5/10 Spatial Index map + 5/10 Statistical map
	b (environmental)	9/10 Spatial Index map + 1/10 Statistical map
	c (social)	1/10 Spatial Index map + 9/10 Statistical map

Table 7.15: Combinations SSI

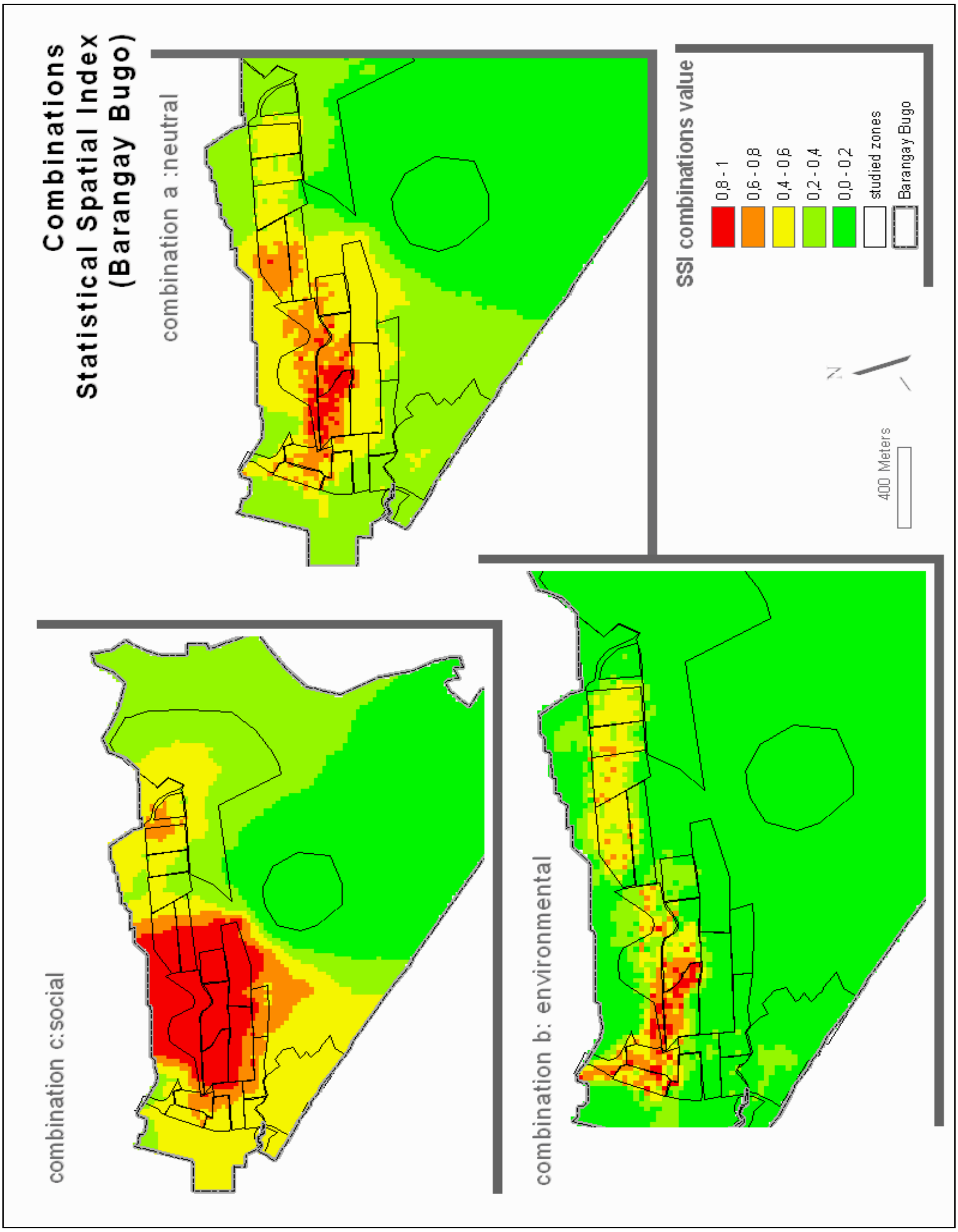

Figure 7.19: Statistical Spatial Index combinations (Barangay Bugo)

On the ‘scenario b’ (environmental), small zones were identified as being suitable for gardening. A large part of the map displayed plots which seem to be not adequate or less adequate regards the UA or SWM perspective, due to the strong influence of low values in the spatial index map, as no houses, which are the basic element of the Spatial Index computation, were located to the south and east of Bugo. Indeed, this would increase the distance between houses and garden.

The ‘neutral scenario, a’ offered opportunities for UA as ‘environmental scenario’ but the main part of the map still displayed zones not adequate for UA and SWM .

With the strong influence of social values, the third combination presented suitable plots essentially located in the west part of the barangay Bugo but also in the east part. The zones were more adequate than in other combinations. Moreover, the area is larger which is quite important in the case of the creation of farmers’ cooperative coming from the same neighborhood which required larger plots to cultivate.

7.4. Replication case findings and discussions

With the ESC approach, with the combination giving more weight to the suitability map (scenario b, environmental), more zones were adequate for urban gardening. With the SSI approach, the same conclusion must be applied with the combination giving only 10% to the non-social map. In ESC approach, the inclusion of social data reduced the number of adequate plots and with SSI approach, the inclusion of social data through the Statistical map enhanced the number of adequate plots regards UA. It could be due to the higher objectivity of including social data through Statistical map vis-à-vis Community map that is more selective, subjective and restrictive by paying attention to the people’s perception.
Moreover, whatever the chosen combination, the north-western part of the Barangay seemed to be more adequate for UA and SW.

The second approach had the advantage of not excluding any zones, as built-up areas in ESC, therefore all the plots had a potential for gardening through for example, a simple plantation of tomatoes along the walls of the houses.

In the case of the replication in Bugo (ESC approach), it would have been useful not to mask houses but to give even a smaller weight to this land use class. In this case, comparison between both approaches would have been facilitated, as all the pixels would have had a value.

In order to test the robustness of the methodology a replication has been carried out in a city larger (Cagayan de Oro) than the pilot zone but presenting the same living conditions such as urban poverty or interest in UA. In the replication zone, the ESC approach identified more zones adequate for urban gardening with the scenario giving highest importance to environmental data. With the SSI approach, the same conclusion is reached with a low importance given to spatial index map.
With the intention to evaluate the impact of community information integration, we investigated the difference between the results of the two approaches (Appendix 12).

This was done by subtracting the result of the SSI approach from the result of the ESC approach. The combination giving the same importance to technical and social aspect of the weighted combination is used (neutral scenario a) in order to interpret the results with less partiality. Through this subtraction, only the community map was highlighted by the way of the "quantitative comparison map" (Figure 7.20). Since the two approaches share environmental and survey information in the case of the replication site, the difference relied only on community map information. When the ESC approach output values were subtracted from the SSI method output values, negative and positive values appeared (Figure 7.20) describing that people and environment choices are in total adequacy (null values) or in opposition for the choice of urban gardening site.

Before any method comparison, a Wilcoxon test (cf. Appendix 12) has been operated in order to evaluate if both approaches are statistically different. The test has confirmed that the distributions of both approaches are significantly different. The comparison is thus possible. Since the difference has been operated for only one site, there is no possible comparison with a theoretical or other empirical value. Therefore, a threshold has been selected in order to have a reference value. As in many statistical operations, the mean has been used as the comparison value and the 'quantitative comparison map' has been classified by the way of the standard deviation method (Figure 7.20). Using this methodology, it is possible to quantify information.

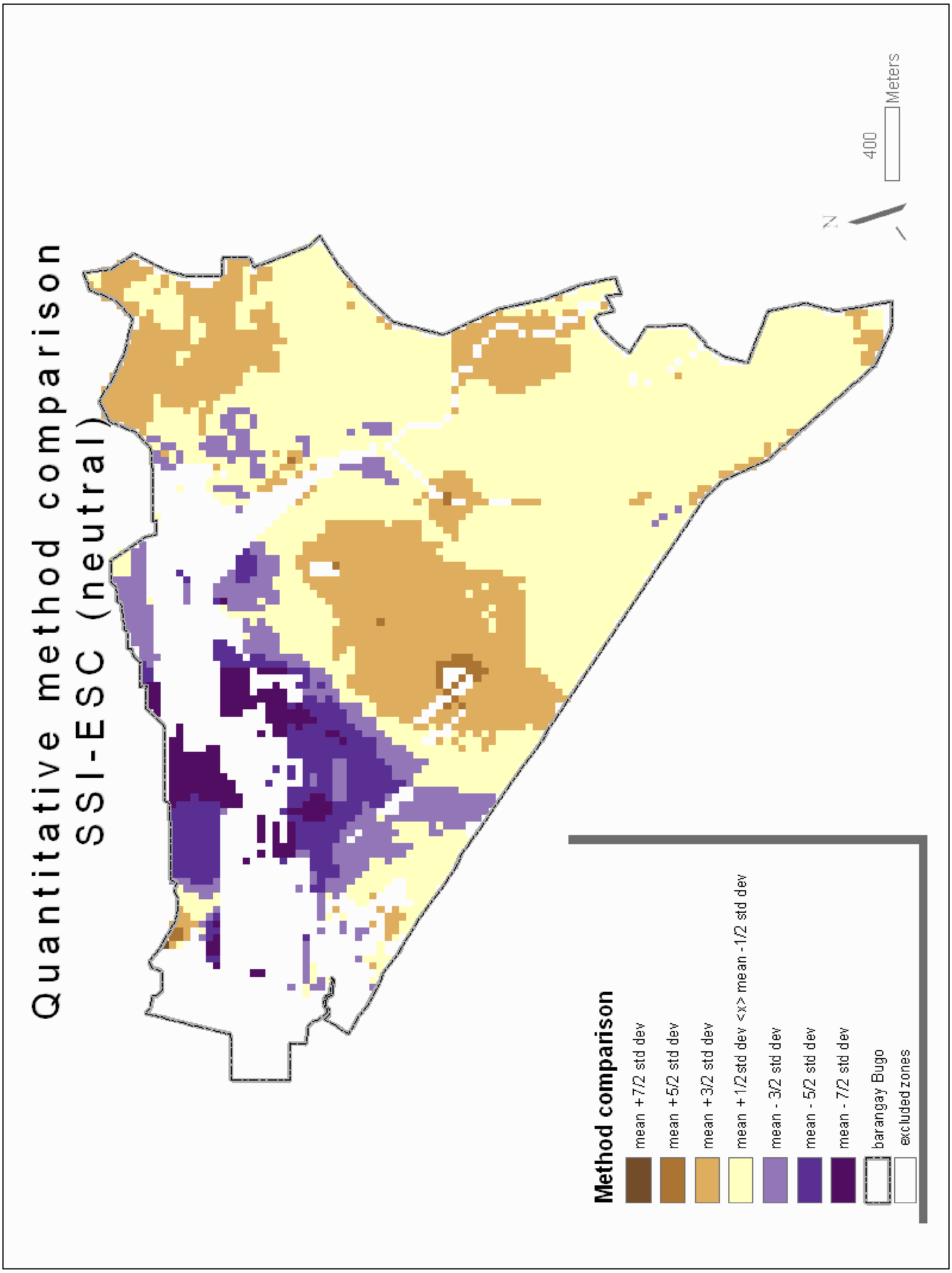

Figure 7.20: Quantitative method comparison in the replication zone (Barangay Bugo); standardized map

It seems that if plots were closed to houses (NW), environment was less prioritized than the social perception (SSI values < ESC values). If plots were far from houses, the social perception attitude (such as distance or motivation) was decreasing and although the environment remained favorable (SSI values > ESC values), people do not prioritize the south of Bugo.

Even if we take into account the social perspective of the communities, the environment concern prevails. This might be due to the lack of preparation of the target communities as far as people awareness, sustainability and livelihood challenges are concerned.

Chapter 8. Conclusions

8.1. Main findings

8.1.1. Methodology

The objective of this research was to implement two approaches for testing PGIS methodology in the context of Urban Agriculture (UA) and Solid Waste Management (SWM) implementation policy:

- One approach maximizing the participative side and minimizing the technical side, called Environment Survey Community approach (ESC);
- Another approach maximizing the technical aspect and minimizing the participative one, called Statistical Spatial Index approach (SSI).

The advantages and disadvantages of working with PGIS were analyzed through a comparison of the two approaches.

The Participative Geographical Information System (PGIS) methodology was applied in the selection of zones (plots or lots) suitable for implementing urban gardening and Solid Waste Management (SWM) in two cities in the Philippines (Bacolod City as pilot site and Cagayan de Oro as replication site). Urban gardening and SWM are linked by the fact that the segregated waste can be used as compost on urban gardens.

A selection of several attributes was implemented for determining the zones suitable from the environmental, social and economic points of view. These attributes were selected by the representatives of each arm of the specific quadpartite partnership of the research: city government, private (landowners), NGO/ communities and specialists or scientists.

Both the ESC and SSI approaches give **environment** the highest priority. By doing so in the ESC approach, a suitability map was created based on a series of attributes that include slope, access to water, access to roads and soil fertility. In the second approach, SSI, a spatial index map was created using a landscape index computed from classified high spatial resolution remote sensing data.

The second highest priority given by both approaches was the **social situation** of the pilot communities. In a social survey, people answered questions about their daily life but also about their motivation, their skills or their awareness of SWM and UA. Using the ESC method, a social map was produced using a linear combination of weighted survey results. Using the SSI approach, the social survey has been analyzed statistically, aiming to characterize the study area with the most important social factors. A statistical map was produced. Transforming the community map into a Community-based map through a mathematical procedure in the ESC approach, added information about needs and perspectives of the communities, making the process more participative.

Thanks to a survey implemented in the pilot zone, information on profitability was been included for the selection of the plots, by producing a Profitability Survey map. Three different scenarios have been selected for each both the ESC and SSI approaches in order to test two extreme situations and a neutral situation. The scenarios were proposed using a weighted combination of the all above-mentioned maps.

First, a weight of 10% was given to the social aspects of the approaches (Social map, Statistical map and Community-based map) and 90% to the technical aspects (Suitability map and Spatial index map), second the opposite situation and third the same weight given to all the components. For both ESC and SSI approaches, a profitability survey map accounting for a weight of 20% of the final scenario was tested on the pilot site only.

8.1.2. Outputs

The main output from the pilot site is that **zones corresponding more to the research target** were prioritized for UA and SWM implementation in both approaches: poor people with low income, with strong knowledge about UA, living in areas of high population density. Therefore, whatever the approach is, non-participative or participative, the zones with the highest potential for urban gardening will be selected. The opposite is also true, since zones with better social conditions and with lowest capabilities for UA were also disadvantaged. The main objective of the implemented approaches is reached since results are in total adequacy with the research communities' target, prioritizing to urban poor areas.

The second main result concerns **the size of the zones adequate for farming** selected by both approaches. Zones selected as adequate for gardening by the ESC approach were smaller than those selected by the SSI approach for the same purpose. This conclusion may be seen as a capability of the ESC approach to select zones with more precision or more strictly than SSI approach. Therefore the approach using community mapping as an additional component appears to more accurately select the plots. The users will have fewer zones to cultivate but more adequate than those selected with the SSI methodology. They may choose also the combination, giving more power to technical data of the ESC/ Profitability approach. However, if less power is given to the community, local people might feel discredited, and hence be less motivated to implement UA and SWM.

Including the **social factor** seems to orientate the selection to zones where UA is not so adequate from an environmental point of view. Even in an extremely favorable environment, the participative side may not be adequate. Therefore, it may be said that environment is very important in implementing UA and SWM; in both zones of application, since if more weight is given to the suitability map or the Spatial Index map, plots located far from houses obtain higher priority with this scenario. Nevertheless, if information on the community is added to the process through social surveys or community mapping, some of these zones seem to be less adequate for urban gardening. Social information gives priority to zones where environment is less favorable for gardening by taking into account the accessibility and their basic needs.

People appear to accurately identify risks such as flooding or low land fertility encountered by each plot of their neighborhood. They imagine that plots with larger area are perhaps more suitable than plots located besides their houses. Even if the soil, fertility and slope are less suitable than in 'housing zones', people keep on hoping to garden a larger plot. In light of that, city-managers have two options. First, to keep the environment as the first priority and allow cultivation just beside the housing zones but this may go against the wishes of local communities. Or they can consider the people's advice as the first priority and will have to practice some environmental management such as the use of manure or terrace agriculture.

8.1.3. Levels of participation

Conceptualizing levels of participation as a ladder was found to be useful. At the lowest rung, we placed the absence of participation of local communities while a total empowerment of people via participation was placed on the highest rung. This research could be classified as a 'functional participation' (ARNSTEIN, 1969) or 'Partnership' (WATES, 2000); this might be the rung located three quarters of the way up the ladder.

The success achieved by the ESC and SSI methodologies was related to the active participation of the population. The project has a sustainability side as people become self-dependent after the intervention, which was, at the beginning, an external initiative.

The study shown that people prioritize this social perception over the environmental factors for UA and SWM implementation.

Nevertheless, communities are not the real final decision-maker as it is normally the case with this level of participation; political leaders will make the final decision as to the direction to take (outlined here in the scenarios). The consultation process must be enhanced in order to promote responsible active participation.

8.2. Discussions

8.2.1. Questions Raised

Two questions must be in light of these conclusions

1) Is the manner of interviewing people as good as it could be? Are the questions relevant enough to understand the phenomenon?

In the case of the pilot site and the replication site, it clearly emerged that communities are motivated for UA and SWM but are not at all aware of the benefits of these practices. People are motivated to do these activities but they do not know why they should do them. They clearly answer negatively to the question about awareness in the social survey. The low priority they give to the allotment features in the pilot zone again indicate their lack of awareness about the benefits of UA. But, in the case of the replication site, the communities give a high priority to allotment features. This apparent contradiction leads to the conclusion that preparation of local people about the benefits of urban gardening and SWM is important. Moreover, it must be clear that NGOs have a strong influence on people and may orientate local people in their reflection.

Awareness about practices is not the only important consideration in terms of UA and SWM. Skills, motivation or time to implement allotment gardening are also required and perhaps the communities of the pilot and replication sites are not yet ready for UA. This conclusion indicates that even if the environment is the ideal, people's awareness is a fundamental step before such practices can be successfully implemented. A parallel may be drawn with the Green Revolution, where seeds or tractors were given to people without any training and only a very few people were able to produce cereals (DOLAN, 1991). For sustainable development, the process application should be a bottom-up procedure and not the reverse.

In order to answer the question about the way people are interviewed, the second approach (SSI) must be considered. In this approach, the social aspect is only covered by a social survey and not through a community map. It is clear, in both cases (pilot and replication sites), that if more importance is given to social data, larger zones received priority from the people. The social survey interviewed people about their current situation. No questions were asked about their perspectives concerning their future daily lives compared to the ESC approach where local people draw their own future perspectives on the community map (for example the location of a potential urban garden or the quality of water source).

2) Is the negative influence of the social aspect due to the fact that people are not aware enough of the benefits and advantages of the practices ?

In order to answer this question, a replication of the same methodology on the same zone within an interval of two years should be carried out, after urban gardens are implemented. Over the course of the following two years, for instance, people could be trained about UA and SWM. At the end of the training process, a map combination, giving priority to social aspect could be analyzed again, and it should be possible to see if people select zones for urban gardening where the environment has also been identified as suitable. A 'comparison map' between ESC and SSI approaches that will show no difference between both approaches will indicate that people's priorities are compatible with environment suitability on a UA point of view. Any differences between the two approaches will orient the governmental policy for or against people's priority (ethical concern).

8.2.2. Time and costs concerns

As one of the specific objectives of the current research is to orientate potential user of the methodology, a comparison in terms of time and cost is necessary.

8.2.2.1. Time analysis

- ESC

ESC is more time-consuming than the SSI method for several reasons. First, communities are integrated in the project as one of the main actors and thus require more time in the consultation process. Moreover, in order to practice a relevant consultation process, the community mapping activity has to be well conducted. It includes time for city managers' training, (about 3 days), and time for community consultation for priorities attribution (about 2 days per community map) including digitizing technical data and computation. Moreover, at least two more days are needed for final consultation or feed back to the communities at the time of features weights attribution and at the end of the process.

Including a participative side in the process therefore requires at least 3 days for the whole set of communities plus 4 days per community. It must be clear that this time does not include the process of local communities' awareness building about the advantages of UA or SWM and the importance of giving them advice about these processes.

A remote sensing image classification may require 3 days for an unsupervised classification, which is sufficient in the ESC approach.

In total, the participative process takes one week per community, which is quite short compared to some suitability data acquisition. The time consumption for this latter data acquisition is dependent on the socio-political context of the pilot site. It may take one day or one month depending on the pre-established relationship between partners. Moreover, primary data is often easily available but ancillary data or data that are more specific can require more time. Five days must be added to the establishment of the approach for data processing.

- SSI

In the second approach, computing a statistical analysis such as the Spatial Index may require 2 days, depending on the expert's knowledge.

The discussion about weights attributed to features or to the combinations requires a few days in both processes. Moreover, a remote sensing image classification may require three weeks for an object-oriented classification process, which is recommended, for an SSI approach. The social and profitability surveys, used in both approaches, requires time for :

- preparation by the researcher→ 2 days
- discussions between researcher and local interviewers in terms of feasibility→1day
- the interview itself→3 days per community for the social survey or one day for the profitability survey as fewer households are interviewed
- analysis of results by the researcher→ 2 days.

In conclusion, both approaches need about 35 days in order to be established.

Therefore, the advantage offered by the first approach is only computed as 1 week for community process and 1 day for consultation on suitability map weights; a time almost equal to statistical analysis and spatial index computation. The time used for the remote sensing image classification may give advantage for ESC approach in the case of an unsupervised classification process application.

Consequently, if suitability data acquisition is relatively fast and if object-oriented classification process is chosen in both approaches, the time consumed by each approach is almost equal.

8.2.2.2. Cost analysis

- ESC

Cost could be a comparison point also for both approaches. The first approach requires money for the implementation of the community mapping process, currently costing about 500€ (for 4 sites) since trainers have to receive an allowance. Moreover, the acquisition of suitability data may be zero or expensive depending on the partnership data agreement.

- SSI

The second approach, due to the Principal Component Analysis, requires statistical software costing at least 500€. Both approaches require the purchase of specific products like a GIS or remote sensing software for a total cost of nearly 3000€, depending on the type of license such as education or private. Free software is also available but it requires specific skills and technical competence. The implementation of the social and profitability surveys are also costly (50€ per survey) since the interviewers must receive an allowance even if sometimes it is only food for his family.

The total cost of the SSI approach is higher due to the purchase of statistical software and specific remote sensing software capable of image classification. Moreover, the first approach may be quite inexpensive due to the quality of the partnership.

Time and cost consumption	ESC approach	SSI approach
Time	About 35 days	About 35 days
Cost	2600€	3100€

Globally, the ESC approach is advantageous in terms of *cost and time* and is *participative*.

The ESC is more tedious but more detailed. More data is needed but the result is also more *comprehensive*. Specifically within ESC, communities' advice and perspectives are included as well as environmental data. As more maps make up this first method, more possibilities of combinations are offered to the user.

The second method, SSI, requires less data but is less participative. This method requires *less fieldwork*. This advantage should not be neglected in context of *difficult data acquisition*. In the *case of a weak NGO network*, the second approach is more appropriate. Nevertheless, the SSI approach requires a strong statistical approach and remote sensing data analysis expertise.

Finally, both approaches present the disadvantage of using data interpolation if difficulties are encountered in data acquisition. This may lead to bias in the results.

8.2.3. Quadpartite concerns

In this project an NGO acted as a go-between. This can bring advantages and disadvantages. NGOs may serve as interpreters for specialists who do not speak the local dialect. However care must be taken to ensure that translations--particularly of scientific terms--are done appropriately. On the other hand, the NGO can often positively fill in gap of the specialists' knowledge about local context.

The difficulties encountered in such projects, with an intermediary person, relate also to the fact that specialists have to give feedback for each step of the procedure and justify all their decisions. If researchers do not include all the ideas or needs of people in the methodology, they have to discuss with people, to argue their decision. It may add tensions in the decision-making process but the NGO could play a mediator role in the discussion.

Specialists are in direct communication with the NGO and a fortiori with the local communities for their knowledge sharing.

Working through an NGO however does add a step in the procedure, since this is an additional stakeholder to include in the partnership. Working with a large partnership can be difficult in terms of time-sharing and opinion divergence. This can appear in the choice of the weights for the final scenario. The NGO chose three combinations of maps that, according to them, would help the expert analyzing the differences in importance between the technical data and the data from the community. However, if many possibilities of weight combination exist and each of them has an interesting land planning output, testing two extreme scenarios and a neutral one is relevant.

Nobody, even specialists and NGO, have the capability to select the best scenario before it. Furthermore, the success of the implementation does not depend only on the choice of the combination but also on the final choice of the scenario by political leaders and the communities' will according to the priority and the philosophy of the planners.

8.3. Limitations of the study

8.3.1. The small size of the pilot site

Results coming from a small area may be contested. However, this small area allows us to have access to data at any time and with a short delay in acquisition. Moreover, the strong partnership enables rapid verification of results. These working conditions are unique and people who would like to replicate methodology should be conscious of those facts. Still, the replication on a larger zone would strengthen the results.

8.3.2. The differences in data for the replication zone

The comparison between pilot case and replication zone was not made with the same set of input data. Therefore it was not possible to check some working assumptions. The conclusions that were drawn from the replication might be considered weaker than it could have been if checking is possible.

8.3.3. The non integration of the a priori position of landowners

Even if landowners are not predisposed to rent land, through discussions with other owners they might be convinced of the benefits of gardening. In the case of the pilot site, private owners did agree to rent their land and urban gardening was practiced for a time.

In the case of the replication site, the lack of discussions with owners at the start of the process has led to a categorical refusal to rent their lands.

8.3.4. The sustainability challenge of the project

This cannot be yet analyzed since urban gardening has been implemented for only 3 years. This time period is too short to evaluate the attitude of the political leaders about the outputs of this research, even if some positive signs are noted (e.g. affective data sharing and good consultation process among others).

8.4. Final conclusions

People who would like to use the methodologies evaluated in this research should be aware that the quality of the replication could depend on the scale of the zone; a small zone presents advantages for data acquisition facility and verification of results but a lower potential for duplication.
The success of such a project cannot be measured in terms of quantity of maps, but in terms of sustainability of the project and the level of consciousness of local communities and all other stakeholders about their environment.

Going back to the general objective of this research, three questions need to be answered.

8.4.1. Can a PGIS support the selection of plots most appropriate for UA in a perspective of food security ?

In general this question could be answered positively :

This research has demonstrated that PGIS one of the most appropriate methodologies that support the selection of plots appropriate for urban gardening. This was shown by the urban gardening practiced on the demo-garden previously selected by the method.

The perspective of food security can be partly reached with the help of PGIS but with some conditions :
- Acceptance of the project by the communities,
- Training on UA offered to the communities,
- Motivation of all the partners,
- Official agreement between the government and other partners is important in terms of data acquisition, and time-consumption.

It is also important for the community to be aware that the government is a partner here considered at the same level. Researchers must be conscious that with this powerful decision making-tool, the government may or may not give priority to communities. They have a moral responsibility to promote scenarios that respect the wishes of all the stakeholders.

Food security can be reached if the knowledge people have about UA and SWM are included. This point has been validated by the capability of people to sell vegetables and fruits on a local market from a demo garden located in the pilot site as well as on the replication site.

These conditions can only be achieved with an informed dialogue between all the partners forming the specific quadpartite partnership of the elaborated methodology.

8.4.2. Does quadpartite partnership increase the effective participation in PGIS?

Quadpartite partnership is a way to increase effective participation but requires a number of conditions to be successful such as a good organization inside the communities or open-mindedness on the part of the land owners. These conditions have been filled in both study sites but are difficult to implement since the management of four partners is a hard task that specialists have to manage. Some political problems have been avoided by researchers in the case of replication site by example.

Nevertheless, in the pilot site, an official agreement with the government facilitated discussions. Moreover, the strong relationships between communities and NGOs have positively influenced the decision of communities and their motivation as well as the attitude of the government, which was more open to the consultation process.

A quadpartite partnership is perhaps hard to implement but is a key for the success of project sustainability and democracy.

8.4.3. Can PGIS facilitate the active participation of local communities?

PGIS may be considered as one of the most appropriate tools if the participation that is hoped for is ‘equitable participation’ or ‘active participation’.

PGIS should be implemented with an interactive participation mentality or with a bottom-up approach. Indeed, people's participation is an important added value to sustainable development. Moreover, in order to reach sustainable development, the participation should be equitable.

Some lessons were learned :
- awareness of local communities as well as some degree of expertise in GIS and CM of the city managers were essential for the implementation process;
- including the knowledge of local communities is a key to success.

The methodology could be used by other city-planners in different socio-political contexts. It is obvious that the primary conditions for success are the specificity of the partnership, a quadpartite partnership present since the beginning of the project implementation.

8.5. Perspectives

8.5.1. Technical perspectives

The classification of remote sensing data in urban areas is quite complex. The pixel classification may be improved with a method that classifies pixels into low density and high-density housing. The difficulty remains for multifunctional buildings in the cities of developing countries. An automated method that extracts population and dwelling units from high-resolution images must be developed in order to meet the needs of city-planners. Beyond landscape criteria, it would be relevant to integrate economical criteria such as access to loans or cost of technical tools.

In order to enhance the quality of the second approach (SSI) it would be useful to integrate the computation of other spatial indices such as the Entropy Index or textural index (Haralick) as it is generally assumed that a patch of houses in a rich zone is more homogeneous than in a poor zone. Moreover, a diversity index could also be computed in order to strengthen the assumption about the shape of the squatter zones, identified more as an accumulation of small houses and richest zones identified as zone of large houses.

Interpolation of data was used in several steps of both approaches. The Inverse Distance Weighted method has disadvantages, such as to not preserve ridges, or to consider points with the same location as duplicate. This may affect the result of the interpolation (WATSON and PHILIP, 1985). It could be useful to test other methods of interpolation, which might be more adequate to the data type.

8.5.2. General perspectives

In order to find an approach covering all the social aspects of the area, it is be relevant to think about a unique, participative way of considering the community perception and situation. And as proposed before, the methodology could be used twice; once at the beginning of the research to evaluate the situation and once two years after to evaluate the impact of UA on the community perception.

As all the cities in developing countries have their own socio-political context, it is difficult to establish a universal methodology corresponding to all the criteria of the developing cities. Nevertheless, in many developing countries, the context might be sensitive due to the lack of democracy, or the lack of implementation of democracy.

A replication on a larger zone such as the sum of all cities from a country with the same poverty condition as the pilot case could be a way to test the efficiency and the robustness of the methodology.
The replication on a larger site would also allow a sensitivity analysis to be carried out. This is used to evaluate to what extent the output is affected by any change in the inputs. It allows understanding the effect of probable changes in the inputs or in the weights. It allows selecting the elements that are important for a comprehensive answer and those that could cause disagreements between the stakeholders. In our research, only the most important elements for the elaboration of the Plan have been picked out. The changes in the inputs are only due to the changes of the geographical location.

In contrast to more traditional or non-digital methods, new forms of participation based around Information Communication Technologies are beginning to evolve. These include online discussion, web surveys and online decision support systems. Together these form what might be termed the e-ladder participation as shown in Figure 8.1.

Working with this new e-ladder of participation may be seen as a perspective for the current research since nowadays, online discussions or online decision support are effective. The participation of the citizens, to the electronic map for example, may be anonymous, which is interesting in case of socio-political conflict between people, but unfortunately, not all communities have online access.

This process can thus be viewed as anti-democratic since access is unequal. In the case of the Republic of the Philippines, only a few people would have access to the web and this class is also the one who takes most of the decisions in the country. In conclusion, this e-ladder is not yet applicable in most of the developing countries for a democratic decision process. However, some attempts are successful as in Bangladesh with the Grameen Bank using the technology for the selection of rural women in order to provide access to collateral free loans (LARANCE, 1998)

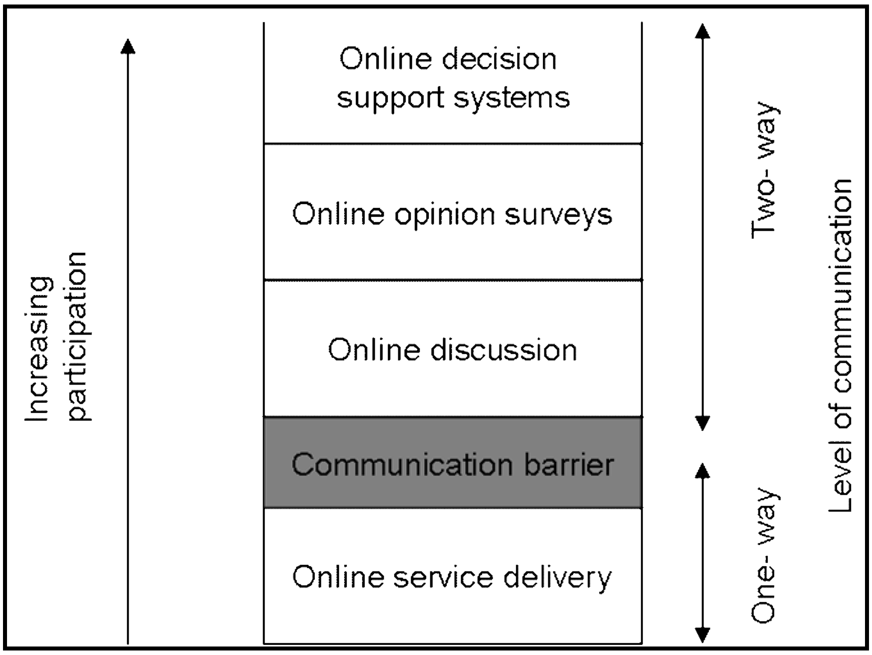

Figure 8.1: The new e-ladder participation (CARVER, 2001; After SMYTH, 2001)

In order to reduce cost of the community mapping process, a community forum could be held (MCCALL, 2003). No specific training is necessary for the expert, and the NGO could facilitate the forum (WATES, 2000). This forum can be seen as a meeting where all people interested by the project could debate without any specific implication for the process. This allows collecting the advice of most of the people without any social segregation as can be encountered in a community mapping process. However, this type of meeting can lead to a feeling of inequality since the forum is sometimes held during the evening at specific times, limiting the numbers of people who can attend. People are therefore partially informed or cannot really discuss.

As competent use of GIS techniques requires training, a multi-criteria model with a posterior spatialization could facilitate the choice of the adequate plots by any simple interaction with the software. This could be done by communities and it might increase the participation of local people. As there is a lack of detailed spatial references, plots are only selected on their identification profile. Therefore, geospatial data are not included in the process. It might be suggested to add a strong research in geostatistical data processing to better take into account the spatial correlation of the plots.

This research represents an important step about participative work and PGIS has been made in the context of UA. Some perspectives for further research have been exposed. The methodology suggested here may be used in various other topics that might benefit from the integration of the community knowledge and experiences into a governmental analysis. Hopefully, this research will contribute to reinforce democratic processes of decision.

Appendix

Appendix 1: Object-oriented classification: concepts and definitions

1) *Landscape*

Classically this concept is defined as an area of land containing an interacting mosaic of patches or landscape elements. In the current research, the landscape is the urban environment of the Barangay 7 with all the classes of the area. Considering the scale of the landscape, there is no absolute size since as organism and phenomenon scales the environment differently.

2) *Patch*

These are the basic elements or units that constitute a landscape or a spatial contiguity of a class. In our case, this is a mix between the pixels of our satellite image and class of the classification of the same image. In order to complete the definition of the patch, we must keep in mind that a landscape does not contain a single patch mosaic, but contains a hierarchy of dynamic patch mosaics across a range of spatial and temporal scales.

In the computation of metrics, the landscape is considered as a population of patches and every patch is counted.

Example: The landscape below is made up of 14 individual polygons/patches. The landscape is made up of three classes; Conifer, Mixed wood and Deciduous. The Conifer class includes four patches (2, 3, 11 and 13), the Deciduous class includes five patches (4, 7, 8, 10 and 14) and the Mixed wood class includes five patches (1, 5, 6, 9 and 12). When Patch Analyst generates statistics at the class level, it calculates values for each class. In contrast, at the landscape level it calculates a single value for all patches, irrespective of class.

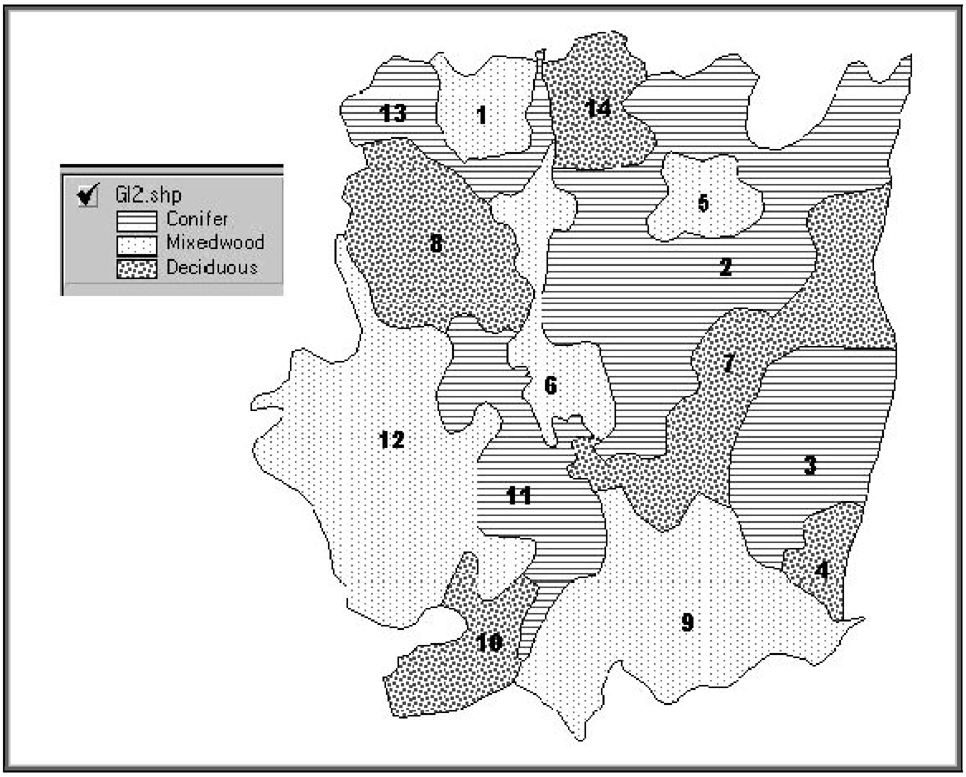

Figure A.1: Patch and landscape in Patch Analyst (MACGARIGAL and MARKS, 1994)

Appendix 2: Spatial Indexes

3) 1) Area metrics

Area metrics represent the first step in the analysis of the classification. Landscape will be analyzed related to its composition, not its configuration. The basic concept is the Area.

a) Class area (CA)

This index is a measure of landscape composition; specifically, how much of the landscape is comprised of a particular patch type.

$CA = \sum_{j=1}^{n} a_{ij}\left(\frac{1}{10000}\right)$	a_{ij} = area (m^2) of patch ij.
Description	CA equals the sum of the areas (m^2) of all patches of the corresponding patch type, divided by 10,000 (to convert to hectares); that is, total class area.
Units	Hectares
Range	CA > 0, without limit. CA approaches 0 as the patch type becomes increasing rare in the landscape. CA = TA when the entire landscape consists of a single patch type; that is, when the entire image is comprised of a single patch.

→This will facilitate the general identification of each purok in the barangay. We will know if a purok is more oriented through 'houses' only or trough a mix between 'houses and garden' or even through 'garden' only.

b) Percent of landscape (%LAND)

This index computes the percent of landscape occupied by each patch type. It may be more adequate comparing to CA for the analysis of landscape of varying sizes.

$PLAND = P_i = \frac{\sum_{j=1}^{n} a_{ij}}{A}(100)$	P_i = proportion of the landscape occupied by patch type (class) i. a_{ij} = area (m^2) of patch ij. A = total landscape area (m^2).
Description	PLAND equals the sum of the areas (m^2) of all patches of the corresponding patch type, divided by total landscape area (m^2), multiplied by 100 (to convert to a percentage); in other words, PLAND equals the percentage the landscape comprised of the corresponding patch type. Note, total landscape area (A) includes any internal background present.
Units	Percent

Range	$0 < PLAND \leq 100$ PLAND approaches 0 when the corresponding patch type (class) becomes increasingly rare in the landscape. PLAND = 100 when the entire landscape consists of a single patch type; that is, when the entire image is comprised of a single patch.

→ It will give a more accurate definition of each purok composition since it is dependent on the varying sizes of the different puroks' landscapes.

c) Largest Patch Index (LPI)

The LPI quantifies the percentage of total landscape area comprised by the largest patch.

$LPI = \frac{\max_{j=1}^{n}(a_{ij})}{A}(100)$	a_{ij} = area (m^2) of patch ij. A = total landscape area (m^2).
Description	LPI equals the area (m^2) of the largest patch of the corresponding patch type divided by total landscape area (m^2), multiplied by 100 (to convert to a percentage); in other words, LPI equals the percentage of the landscape comprised by the largest patch. Note total landscape area (A) includes any internal background present.
Units	Percent
Range	$0 < LPI \leq 100$ LPI approaches 0 when the largest patch of the corresponding patch type is increasingly small. LPI = 100 when the entire landscape consists of a single patch of the corresponding patch type; that is, when the largest patch comprises 100% of the landscape.

→ A notion of dominance will appear in our analysis.

4) <u>2) Patch density, size and variability metrics</u>

These not spatially explicit measures are best considered as representing the configuration of the landscape.

a) Patch Density (P.D.)

By the way of this index, comparisons among landscapes of varying size may be facilitated. The interpretation of the index can be summarized as a question of fragmentation as a landscape with a greater density of patches of a patch type would be considered as more fragmented than a landscape with a lower density. With a great value of density, the landscape is more heterogeneous.

PD is always positive, without any limit.

/	n_i =number of patches in the landscape of patch type (class) i. A =total landscape area (m^2).

Description	PD equals the number of patches of the corresponding patch type divided by total landscape area (m^2), multiplied by 10,000 and 100 (to convert to 100 hectares). Note, total landscape area (A) includes any internal background present.
Units	Number per 100 hectares
Range	PD > 0, constrained by cell size. PD is ultimately constrained by the grain size of the raster image, because the maximum PD is attained when every cell is a separate patch. Therefore, ultimately cell size will determine the maximum number of patches per unit area. However, the maximum density of patches of a single class is attained when every other cell is of that focal class (i.e., in a checker board manner; because adjacent cells of the same class would be in the same patch).

→ Puroks will be analyzed with a homogeneity characteristic. If the class is very dense, we conclude that poor people are living there, and this is the opposite for rich people situation.

5) 3) Shape metrics

The shape metrics are able to quantify landscape configuration in terms of the complexity of patch shape at different levels of analysis. Shape is a difficult parameter to quantify concisely in a metric.

a) Mean Shape index (MSI)

This index measures the complexity of a patch shape comparing it to a standard shape.

$MSI = \sum_{i=1}^{m}\sum_{j=1}^{n}\left[\left(\frac{0.25p_{ij}}{\sqrt{a_{ij}}}\right)\right]$	p_{ij} = perimeter of patch ij in terms of number of cell surfaces. a_{ij} = area (m^2) of patch ij.
Description	MSI equals the sum of each patches perimeter divided by the square root of patch area (hectares) for each class (Class Level) or all patches (Landscape Level), and adjusted for circular standard (polygons), or square standard (grids), divided by the number of patches
Units	None
Range	MSI is greater than one, MSI = 1 when all patches are circular (polygons) or square (grids)
Comments	Measures the average patch shape or the average perimeter-to-area ratio for a particular patch type of for all patches in the landscape

→ This may introduce a difference between rich 'houses patch' and poor 'houses patch'.

b) Area Weighted Mean Shape Index (AWMSI)

This index focuses on patches according to their sizes. Largest patches are weighted more heavily than smaller patches in calculating the average patch shape for the class or landscape.

$$AWMSI = \sum_{i=1}^{m}\sum_{j=1}^{n}\left[\left(\frac{0.25p_{ij}}{\sqrt{a_{ij}}}\right)\left(\frac{a_{ij}}{A}\right)\right]$$	p_{ij} = perimeter of patch ij in terms of number of cell surfaces. a_{ij} = area (m^2) of patch ij. A =total landscape area (m^2).
Description	AWMSI equals the sum, across all the patches, of each perimeter (m) divided by the square root of patch area m^2, adjusted by a constant to adjust for a square standard, multiplied by the patch area m^2 divided by total landscape area. AWMSI equals SHAPE weighted by patch area so that larger patches weight more than smaller ones.
Units	None
Range	AWMSI ≥ 1, without limit. AWMSI = 1 when all patches in the landscape are square; AWMSI increases without any limit as the patch shapes become more irregular.
Comments	MSI with weighting patches according to their size

6) <u>Contagion and interspersion metrics</u>

These metrics quantify landscape configuration.

a) Interspersion and Juxtaposition index (IJI)

This metric quantify landscape configuration, measuring patch adjacency and not cell adjacency like in CONTAG index. "The interspersion index measures the extent to which patch types are interspersed; higher values result from landscapes in which the patch types are well interspersed (i.e. equally adjacent to each other), whereas lower values characterize landscapes in which the patch types are poorly interspersed".

IJI approaches 0 when the corresponding patch type is adjacent to only 1other patch type and the number of patch type increases. IJI equals 100 when the corresponding patch type is equally adjacent to all other patch types (i.e., maximally interspersed and juxtaposed to other patch types). IJI is undefined and reported as N.A. if the number of patch type is less than 3.

	e_{ik} = total length (m) of edge in landscape between patch types (classes) i and k. m = number of patch types (classes) present in the landscape, including the landscape border, if present.
Description	IJI equals minus the sum of the length (m) of each unique edge type involving the corresponding patch type divided by the total length (m) of edge (m) involving the same type, multiplied by the logarithm of the same quantity, summed over each unique edge type; divided by the logarithm of the number of patch types minus 1; multiplied by 100 (to convert to a percentage). In other words, the observed interspersion over the maximum possible interspersion for the given number of patch types. Note, IJI considers all patch types present on an image, including any present in the landscape border, if present. All background edge segments are ignored, as are landscape boundary segments if a border is not provided, because adjacency information for these edge segments is not available and the intermixing of the focal class with background is assumed to be irrelevant
Units	Percent
Range	$0 < IJI \leq 100$ IJI approaches 0 when the corresponding patch type is adjacent to only 1 other patch type and the number of patch types increases. IJI = 100 when the corresponding patch type is equally adjacent to all other patch types (i.e., maximally interspersed and juxtaposed to other patch types). IJI is undefined and reported as “N/A" in the "basename".class file if the number of patch types is less than 3.
Comments	*Interspersion and juxtaposition index* is based on *patch* adjacencies, not *cell* adjacencies. As such, it does not provide a measure of class aggregation like the contagion index, but rather isolates the interspersion or intermixing of patch types.

→ The interspersion index will orientate our analysis through the mix between all the classes.

Appendix 3: Profitability and rent: definitions and concepts

production: process of combining and coordinating inputs (resources or factors of production) in the creation of good and service (COLMAN, YOUNG, 1989).

production function: $Q=f(X_1, X_2, \ldots, X_n)$

Q: quantity of a specific product produced in a given time period
X_1, X_2… X_n: quantities of an unspecified number (n) on inputs employed in the production process (ex: usage of fertilizer…)

The quantity of inputs must be adequately computed in order to reach the optimal production as the curve of production shows :

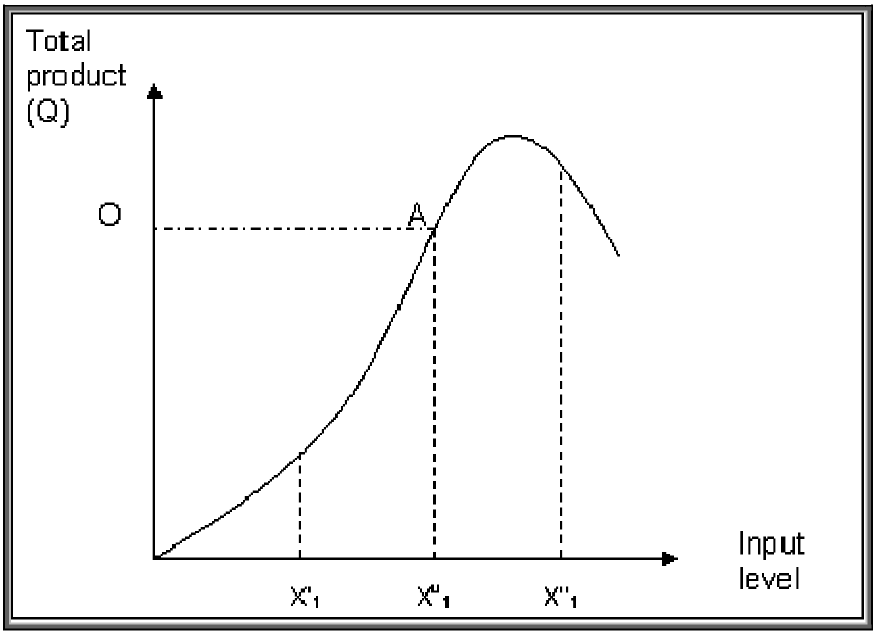

Figure A2: Production function (adapted from COLMAND, YOUNG, 1989)

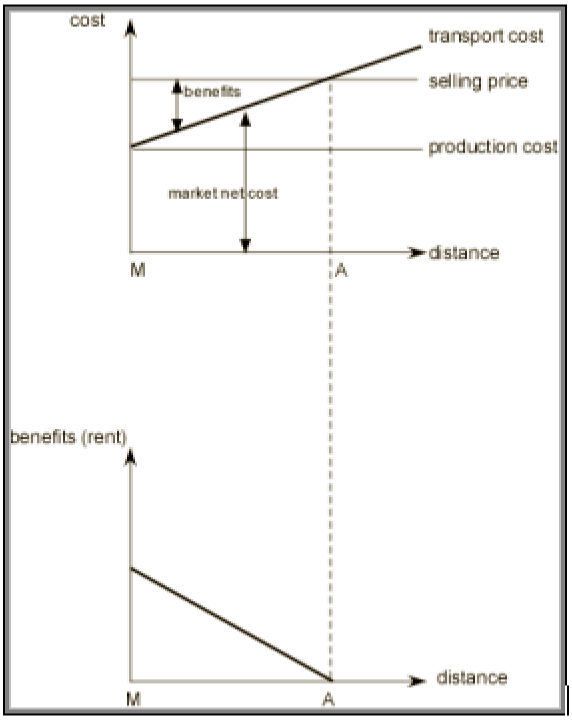

Figure A3: Production function (adapted from COLMAND, YOUNG, 1989)

As more fertilizer, X_1 for example, is used, output Q will increase to a maximum. Further application of fertilizer will reduce the quantity produced.

Average product (AP): $Ap_{x1}=Q/X_{1:}$ total product divided by the amount of variable input (on the figure, OA, average product of X_1 at input level X^0_1

bid rent: the amount of money offered to purchase a piece of land

bid rent function: the notion that land is allocated the use that earns the highest location rent

location rent: the advantage of one plot of land over another because of its location; the concept of declining rent with an increase in distance from the market
rent: payments made to land-owners as a productive factor for their contribution to the productive process and the operation of economy. The payment to a factor over and above that necessary to keep it in its present occupation. Rent may vary from one place to another because for a variety of reasons including its location, distance from a market place or its productivity.

economic rent: the value ascribed to land. Economic rent may also be defined as a return to a fixed factor earned because of the scarcity of some quality it possesses; accessibility is one of the influencing factors on economic rent;

economic optimum: to reach the economic optimum usage of a single variable input, the producer needs :

- The marginal product of the input which indicates the contribution to total output which an additional unit of the input would make;
- The price per unit of the final product;
- The price per unit of the variable input.

Economic optimum, yielding maximum profits, will be allowed where the value of the marginal product of the variable input is equated to its price.

total costs: The total costs are divided into two parts

fixed costs: which are associated with the fixed inputs (rents, depreciation on farm building, etc…) and which are independent on the level of output

variable costs: which arise from employing the variable factors of production such as feed, fertilizer, etc…

total costs are therefore the sum of fixed and variable costs.

The firm (farm…) will achieve its desired state of equilibrium when profits (Л), defined as the difference between total costs and total revenue, are maximised.

Appendix 4: Tables used from the Socio-Economic profile of Bacolod City

TITLE
Comparative Land Use
Existing Land Use, 2000
Historical Population Growth, Annual Growth Rate, 1948 - 2000
Comparative Bacolod City (Urban) Population, 1995 and 2000
Comparative Bacolod City (Sub-Urban) Population, 1995 and 2000
Total Population, Household Population and Number of Households, Bacolod City, 1995 and 2000
Total Population, Land Area and Population Density by Barangay, Bacolod City, 2000
Bacolod City Population Projection, Urban Barangay
Bacolod City Population Projection, Rural Barangay
Area Devoted to Agricultural Crop Production
Crop Production Program
Fisheries Projects Accomplishments
Profile of Markets
Land Use Allocation (Area in Has.)
Occupied Housing Units, Households Population and Ratio of Households & Household Population to Occupied Housing Units by Type of Building
Occupied Housing Units By Floor Area and Number of Occupants in Each Housing Units
Households By Type of Building and Tenure Status of the Housing Unit
Occupied Housing Units by Condition (State of Repair) of the Building Year Built

Occupied Housing Units by Construction Materials of the Outer Walls & Roof

Occupied Housing Units by Type of Building, Number of Households
In each Housing Unit

Occupied Housing Units by Land Ownership

Households By Usual Manner of Garbage Disposal

Future Police Force Requirement, 2001 – 2006

Garbage Fees Collected, 1990 – 2004

Waste Characteristics By Weight

Local Government Profile, 2001 – 2004

Sources of Income, 2000 – 2004

Appendix 5a: Social survey implemented by the local NGO (form)

Barangay 7 Household Profile

page 1 of 4

resp #

Respondent #:			**Date of Survey**	
Site:			**Enumerator**	
Name of Purok			(Last, First)	

Respondents Name:		**Relation to Family**	
	(Last,First)		

1. HOUSEHOLD COMPOSITION

Name	Age		Sex	Education	in/out of School		Civil Status	Religion
					in	out		
1.1 Husband a.								
1.2 Wife a.								
1.3 Siblings a.								
b.								
c.								
d.								
e.								
f.								
g.								
h.								
i.								
1.4 Other Person a.								
b.								
c.								
d.								
e.								

2. INCOME, EMPLOYMENT & EXPENDITURES PROFILE

2.1 Major Source of Income	Relation/ Name	Average monthly Income	Status of Employment
a.			
2.2 Other Source of Income a.			
b.			
c.			
d.			
e.			
2.2.1 Cultural background (former jobs, job training…)			
2.3 Gross Income per Month	Php		

2.4 if source of income is farming

Sources/ Crop	Quantity		Units	Estimated Value	Sold	Units	Income
a.							
b.							

page 2 of 4

resp #

2.4.1 farm expense

Sources/ Crop	Land area		Units	Expense Type	Expense	Cost
a.						
b.						
c.						
d.						
e.						

2.5 Household Expense

Expense	Week		Month	Annual
a. Rice				
b.meat/ vegetables				
c.fruits				
d.Personnal Effects				
e.education				
f. transportation				
g. clothing				
h. electricity				
i.water				
j. fuel wood/ gas/ LPG				
k.house repair/ rent				
l. medical				
m.recreation				
n. donations				
o. celebrations				
Others:				
p.				
q.				
r.				

k. Is the total income enough to cover your expenses?

3. HOUSING CHARACTERISTICS, HOUSEHOLD ASSETS and FACILITIES

3.1 Housing Characteristics	House	Type of owner (public or private)	Homelot
a. Rent			
b. owned			
c. Others			
d. area (sq. m.)			

Type of *(pls check)*
predominantly wooden
predominantly cement
predominantly light mat
mixed wooden & cement

3.2 Household Facilities

Toilet	a.pity privy		b.Antipolo	c.Water sealed	d.Septic Tank	e.Others	f.none
Lighting System	a.electricity		b.kerosene	c.petromax	d.others		

Water System (+ distance from fields and houses) +quality?	a.pipeline BACIWA		b.Artesian well	c.Open dug Well	d.others	
Cooking Facility	a.gas stove		b.electric stove	c.firewood	d.charcoal	e.others

4. HEALTH STATUS

4.1. Illness

a. Sick member of the family:

	(Name)				(Age)		(Sex)

b.Type of Ailment:

c. Medical Attendance:

d. Is anybody attending to your sick member: Yes No

If yes, who is attending to him/her :
- Doctor
- Nurse
- Midwife
- Herbolario
- Others/Family Members
- None

page 3 of 4

resp #

If no, why?

e. How often do family member get sick? 1x a year 2x a year Several Times

f. What are the common ailments of the family member during the year?

f.1. Ailments among the olds

f.2. Ailments among teenagers

f.3. Ailments among children

g. Where do you usually go when you get sick?
- Brg Health clinic
- MHC/ CHO
- Private Health Clinic
- Hospital
- Others

h. Whom do you go to when you get sick?
- Herbolario
- Midwife
- Nurse
- Doctor

i. What medicines do you take when you get sick?

j. Who administer it to you?

k. Do you have herbal plants in your backyard?

If yes, what are these?

For what ailments do you use them?

4.2. Nutrition

a. How often do members of the family eat the following food?

	Daily		weekly	twice a week	monthly	twice a month
Vegetables						
Fruits						
fish						

Fruits						
fish						
meat/poultry						
beef						
instant noodles						
canned goods						

b. Where do you get your fruits and vegetables? + name of the market

4.3. Immunization

a. Do you submit your children for immunization?
If yes, what are these? DPT / BCG / Polio / Cholera/Typhoid / Etc.
If no, why ______________________________

4.4.Environmental Sanitation
a. What are the types of waste in your household? plastic / paper / bottles / others ______________ / food

page 4 of 4
resp #

b. How do you dispose your garbage? ____________ Burning
____________ Burying
____________ Compost Pit
____________ Throw anywhere
____________ Others
____________ Public garbage cans

c. Do you practice waste segregation at home ______ Yes ______ No (Why?)
If yes, what motivates you to segregate? ____________
What do you do with the segregated waste? ______________ ________
From whom did you learn waste segregation? ______________

d. What household pests are plentiful in your house? __________ Mosquitoes _______ Flies _______ Rats
________ cockroaches ______ ants ______ others
e. How do you destroy these pests? ______________________

5. COMMUNITY RESOURCES

a. How far is your home to the nearest barangay health station? ______________
from the nearest hospital? ______________

b. How often do you avail of the services in your barangay health station?
________ very often ______ often ________ seldom ________very seldom
________ none at all

c. What facilities are present in your barangay?
______ school building ________ health center ________ others

c. What facilities are present in your barangay?

_____________ school building _______________ health center ______________ others
____________ barangay hall ________________ play ground
_____________ church ________________ market

d. Do you have a Botika sa Barangay? ____________ Yes _____________ No
Who runs your Botika sa Barangay? ____________________________ ____
e. What products are sold? ____

f. Are you a member of any organization, club or association in your barangay? ________ Yes ______ No
If yes, what organization? _____________________________
What is your position ? _____________________________

g. Where do you get health information and other news in the barangay? ________________________

h. Do you have any income generating projects in the barangay? ________________ Yes ____________ No
If yes, what is it ? ____________________________
If no, why? __________________________________

i. Do you have the following?

A. Backyard garden	
B. Poultry	
C. Livestock	

j. What is the maximum distance (approximatively) that you are able to *walk* during one day?

6.FUTURE IN THE BARANGAY

6. 1 What are the major problems in the Barangay?What is your vision for your barangay? What do you want your barangay to be in 10 years? (Peace and order, Cleanlyness, security, managemnt…) ____________________________

6.2 What are in your life you want to improve? (education, job security, food security, health…)

Appendix 5b: Answers to the social survey

Husband and Wife

Educational Attainment

Purok: Magnolia

n=hh, couple

n = 64	Husband f	Percentage %	Wife f	Percentage %	Sum
Elementary Level	3	5,45	9	16,67	22,12
Elementary Graduate	3	5,45	2	3,70	9,16
High School Level	9	16,36	13	24,07	40,44
High School Graduate	14	25,45	14	25,93	51,38
College Level	14	25,45	9	16,67	42,12
College/Vocational Graduate	12	21,82	7	12,96	34,78
No Response	9	16,36	10	18,52	34,88
None	0	0,00	0	0,00	0,00

Purok: Coca-Cola

n = 49	Husband f	Percentage %	Wife f	Percentage %	Sum
Elementary Level	9	18,37	3	6,12	24,49
Elementary Graduate	4	8,16	1	2,04	10,20
High School Level	13	26,53	17	34,69	61,22
High School Graduate	12	24,49	11	22,45	46,94
College Level	7	14,29	9	18,37	32,65
College/Vocational Graduate	4	8,16	8	16,33	24,49
No Response	0	0,00	0	0,00	0,00
None	0	0,00	0	0,00	0,00

Purok: Repolyo

n = 12	Husband f	Percentage %	Wife f	Percentage %	Sum
Elementary Level	5	41,67	1	8,33	50,00
Elementary Graduate	1	8,33	6	50,00	58,33
High School Level	0	0,00	5	41,67	41,67
High School Graduate	4	33,33	0	0,00	33,33
College Level	0	0,00	0	0,00	0,00
College/Vocational Graduate	2	16,67	0	0,00	16,67
No Response	0	0,00	0	0,00	0,00
None	0	0,00	0	0,00	0,00

Purok: Tangkong

n = 28	Husband f	Percentage %	Wife f	Percentage %	Sum
Elementary Level	9	32,14	8	28,57	60,71
Elementary Graduate	2	7,14	3	10,71	17,86
High School Level	2	7,14	1	3,57	10,71
High School Graduate	13	46,43	13	46,43	92,86
College Level	1	3,57	0	0,00	3,57
College/Vocational Graduate	1	3,57	3	10,71	14,29
No Response	0	0,00	0	0,00	0,00
None	0	0,00	0	0,00	0,00

Table A1: Social Survey-Educational attainment

Husband and Wife

Age

Purok: Magnolia

n = 64	Husband f	Percentage %	Wife f	Percentage %
20 - 32	7	10,94	14	21,88
33 - 44	18	28,13	13	20,31
45 - 56	21	32,81	21	32,81
57 - 68	10	15,63	8	12,50
69 - 80	1	1,56	2	3,13
81 - 92	1	1,56	1	1,56
No Response	6	9,38	5	7,81

Purok: Coca-Cola

n = 49	Husband f	Percentage %	Wife f	Percentage %
20 - 32	7	14,29	9	18,37
33 - 44	21	42,86	23	46,94
45 - 56	20	40,82	13	26,53
57 - 68	1	2,04	3	6,12
69 - 80	0	0,00	0	0,00
81 - 92	0	0,00	0	0,00
No Response	0	0,00	1	2,04

Purok: Repolyo

n = 12	Husband f	Percentage %	Wife f	Percentage %
20 - 32	0	0,00	1	8,33
33 - 44	6	50,00	6	50,00
45 - 56	3	25,00	5	41,67
57 - 68	2	16,67	0	0,00
69 - 80	1	8,33	0	0,00
81 - 92	0	0,00	0	0,00
No Response	0	0,00	0	0,00

Purok: Tangkong

n = 28	Husband f	Percentage %	Wife f	Percentage %
20 - 32	5	17,86	6	21,43
33 - 44	10	35,71	13	46,43
45 - 56	8	28,57	6	21,43
57 - 68	3	10,71	3	10,71
69 - 80	2	7,14	0	0,00
81 - 92	0	0,00	0	0,00
No Response	0	0,00	0	0,00

Table A2: Social Survey-Age

Children

No. of Children per Household

Purok: Magnolia

n = 64

	f	%
0 - 2	20	31,25
3 - 5	35	54,69
6 - 8	6	9,38
9 - 11	2	3,13
12 - 14	1	1,56

Purok: Coca-Cola

n = 49

	f	%
0 - 2	17	34,69
3 - 5	26	53,06
6 - 8	5	10,20
9 - 11	1	2,04
12 - 14	0	0,00

Purok: Repolyo

n = 39

	f	%
0 - 2	4	33,33
3 - 5	7	58,33
6 - 8	1	8,33
9 - 11	0	0,00
12 - 14	0	0,00

Purok: Tangkong

n = 95

	f	%
0 - 2	10	35,71
3 - 5	12	42,86
6 - 8	6	21,43
9 - 11	0	0,00
12 - 14	0	0,00

Table A3: Social Survey-Age of children

Income

Major Source of Income

Purok: Magnolia

n = 64

	f	%
Boarding House Business	2	3,13
Businessman	2	3,13
Checker	1	1,56
Clothes Washer	1	1,56
Collector	2	3,13
Company Driver	1	1,56
Company Worker	1	1,56
Cook	1	1,56
Dept. Store Employee	1	1,56
Diesel Mechanic	1	1,56
Driver	4	6,25
Eatery	2	3,13
Electriacian	1	1,56
Electrical Rewinder	1	1,56
Factory Employee	1	1,56
Farming	1	1,56
Fruit Vendor	2	3,13
Government Employee	5	7,81
Housemaid	1	1,56
Mechanic	1	1,56
Office Employee	1	1,56
Office Worker	1	1,56
Pedicab Driver	8	12,50
Pension	2	3,13
Salesman	3	4,69
Sari-Sari Store	4	6,25
Security Guard	2	3,13
Tailoring/Store	1	1,56
Taxi Driving	1	1,56
Vendor	1	1,56

	Sum (%)
driver	21,88
vendor	15,63
employee	40,63
laundry	1,56
cooker	1,56
mechanics+construction	3,13

Table A4: Social Survey-Major source of income in purok Magnolia

Purok: Coca-Cola

n = 49

	f	%
Auto Mechanics	1	2,04
Carpenter	2	4,08
Casual Employee	1	2,04
Clothes Washer	1	2,04
Construction Worker	1	2,04
Cook	3	6,12
Driver	5	10,20
Eatery	1	2,04
Forkclif Operator	1	2,04
Government Worker	2	4,08
Janitorial Services	2	4,08
Laborer	2	4,08
Messenger	1	2,04
Office Employee	7	14,29
OFW	1	2,04
Pedecab Driver	4	8,16
Pension	1	2,04
Pipe Fitter	1	2,04
Sales Clerk	1	2,04
Sari-Sari Store	2	4,08
Small Business	1	2,04
Vending	1	2,04
Waiter	1	2,04
Welder	1	2,04

	Sum (%)
driver	18,37
vendor	8,16
employee	36,73
laundry	2,04
cooker	6,12
mechanics + construction worker	10,20

Table A5: Social Survey-Major source of income in Purok Coca-Cola

Major Source of Income		
Purok: Repolyo		
n = 12		
	f	%
Pedecab Driver	2	16,67
Auto Mechanics	1	8,33
No Regular Job	2	16,67
Pension	1	8,33
Charcoal Vending	1	8,33
Bartender	1	8,33
Driver	1	8,33
Vulcanizing	1	8,33
Office Employee	1	8,33
Purok: Tangkong		
n = 28		
	f	%
Office Employee	2	7,14
Vendors	2	7,14
Businessman	1	3,57
Peddler	3	10,71
Construction Worker	4	14,29
Painter	1	3,57
No Regular Job	3	10,71
Buy and Sale	4	14,29
Driver	1	3,57
Sales Boy	1	3,57
Carpenter	1	3,57
Security Guard	1	3,57
Pedecab Driver	3	10,71

Table A6: Social Survey-Major source of income in Puroks Repolyo and Tangkong

Income (philippino peso)

Purok: Magnolia

n = 64

Income	f	%	Mean income (estimation)
Below 1,000	1	1,72	8,62068966
1,000 -5,000	22	37,93	1137,9
6,000 - 10,000	21	36,21	2896,8
11,000 - 15,000	7	12,07	1569,1
16,000 - 20,000	5	8,62	1551,6
21,000 - 25,000	1	1,72	395,6
26,000 - 30,000	1	1,72	481,6
No Response	6	9,38	
		total	8041,22069

Purok: Coca-Cola

n = 49

Income	f	%	
Below 1,000	0	0,00	
1,000 -5,000	26	53,06	1591,8
6,000 - 10,000	19	38,78	3102,4
11,000 - 15,000	2	4,08	530,4
16,000 - 20,000	1	2,04	367,2
21,000 - 25,000	1	2,04	469,2
26,000 - 30,000	0	0,00	
No Response	0	0,00	
		total	6061

Purok: Repolyo

n = 12

Income	f	%	
Below 1,000	0	0,00	
1,000 -5,000	7	58,33	1749,9
6,000 - 10,000	5	41,67	3333,6
11,000 - 15,000	0	0,00	
16,000 - 20,000	0	0,00	
21,000 - 25,000	0	0,00	
26,000 - 30,000	0	0,00	
No Response	0	0,00	
		total	5083,5

Purok: Tangkong

n = 28

Income	f	%	
Below 1,000	0	0,00	
1,000 -5,000	21	75,00	2250
6,000 - 10,000	6	21,43	1714,4
11,000 - 15,000	1	3,57	464,1
16,000 - 20,000	0	0,00	
21,000 - 25,000	0	0,00	
26,000 - 30,000	0	0,00	
No Response	0	0,00	
		total	4428,5

Table A7: Social Survey-Income value

Housing Characteristics, Household Assets & Facilities

Household House Characterization

Purok: Magnolia

n = 64

	Rent		Owned	
	f	%	f	%
House	4	6,56	57	93,44
Homelot	3	7,69	15	38,46

Others					
House			Homelot		
	f	%		f	%
	0	0,00	*squater*	21	53,85

No Response		
	f	%
house	3	4,69
homelot	25	64,10

Purok: Coca-Cola

n = 49

	Rent		Owned	
	f	%	f	%
House	1	2,04	47	95,92
Homelot	0	0,00	25	51,02

Others					
House			Homelot		
	f	%		f	%
parents	1	2,04	*squater*	22	44,90
			parents	1	2,04
			rent	1	2,04

No Response		
	f	%
house	0	0,00
homelot	0	0,00

Purok: Repolyo

n = 12

	Rent		Owned	
	f	%	f	%
House	1	8,33	11	91,67
Homelot	0	0,00	2	16,67

Others					
House			Homelot		
	f	%		f	%
	0	0,00	*squater*	10	83,33

No Response		
	f	%
house	0	0,00
homelot	0	0,00

Table A8: Social Survey-Housing characteristics

Housing Characteristics, Household Assets & Facilities

Household House Characterization

Purok: Tangkong

n = 28

	Rent		Owned	
	f	%	f	%
House	0	0,00	28	100,00
Homelot	0	0,00	2	7,14

Others					
House			Homelot		
	f	%		f	%
	0	0,00	*squater*	26	92,86

No Response		
	f	%
house	0	0,00
homelot	0	0,00

Table A9: Social Survey-Housing characteristics

Housing Characteristics, Household Assets & Facilities

Type of House

Purok: Magnolia

n = 64

	f	%
a. predominantly wooden	14	23,33
b. predominantly cement	9	15,00
c. predominantly light materials	0	0,00
d. mixed wooden and cement	37	61,67
e. no response	4	6,25

Purok: Coca-Cola

n = 49

	f	%
a. predominantly wooden	3	6,12
b. predominantly cement	0	0,00
c. predominantly light materials	1	2,04
d. mixed wooden and cement	45	91,84
e. no response	0	0,00

Purok: Repolyo

n = 12

	f	%
a. predominantly wooden	0	0,00
b. predominantly cement	0	0,00
c. predominantly light materials	0	0,00
d. mixed wooden and cement	12	100,00
e. no response	0	0,00

Purok: Tangkong

n = 28

	f	%
a. predominantly wooden	7	25,00
b. predominantly cement	1	3,57
c. predominantly light materials	3	10,71
d. mixed wooden and cement	17	60,71
e. no response	0	0,00

Table A10: Social Survey-Type of house

Environment Sanitation

1. How do you dispose your garbage?

	Magnolia n =64		Coca-Cola n = 49		Repolyo n = 12		Tangkong n = 28	
	f	%	f	%	f	%	f	%
a. burning	17	23,94	0	0,00	0	0,00	3	10,71
b. burying	6	8,45	0	0,00	0	0,00	0	0,00
c. compost pit	15	21,13	0	0,00	0	0,00	0	0,00
b. throw away	2	2,82	33	67,35	7	58,33	7	25,00
e. others:	31	43,66	16	32,65	5	41,67	18	64,29
garbage collector								
throw in the Eco-Center								
bring to other places								

2. Do you practice waste segregation at home?

	Magnolia n =64		Coca-Cola n = 49		Repolyo n = 12		Tangkong n = 28	
	f	%	f	%	f	%	f	%
Yes	25	40,98	14	28,57	1	8,33	9	32,14
No	36	59,02	35	71,43	11	91,67	19	67,86

2.1. If Yes, what motivates you to segregate?

Magnolia n =25

	f	%
a. neatness	1	8,33
b. health, cleanliness, to drive away mosquitoes	3	25,00
c. prevent pollution	1	8,33
d. cleanliness	3	25,00
e. I can generate money on it	4	33,33
f. No Response	13	52,00

Coca-Cola n = 14

	f	%
a. I can generate money on it	8	57,14
b. To follow the SWMT City Ordinance	4	28,57
c. To help our community clean and minimize garbage	2	14,29

Repolyo n = 1

	f	%
a. I can generate money on it	1	100,00

Tangkong n = 9

	f	%
a. To avoid mosquitoes and flies	3	30,00
b. To avoid sickness	3	30,00
c. I can generate money on it	2	20,00
d. To minimize waste	1	10,00
e. To hasten the process of disposing garbage	1	10,00

2.2. What do you do with the segregated waste?

Magnolia n =25

	f	%
a. recycle	5	27,78
b. put it in a sack then throw it in a garbage can	3	16,67
c. sell them	8	44,44
d. dispose properly	1	5,56
e. throw it	1	5,56
f. No Response	7	28,00

Coca-Cola n = 14

	f	%
a. recycle	5	26,32
b. sell them	8	42,11
c. throw it in the Eco-Center	6	31,58

Repolyo n = 1

	f	%
a. throw it in the Eco-Center	1	100,00

Tangkong n = 9

	f	%
a. sell them	1	6,67
b. segregate	6	40,00
c. throw it in the Eco-Center	8	53,33

2.3. From whom did you learn waste segregation?

Magnolia n =25

	f	%
a. own self	5	20,00
b. government	8	32,00
c. media	3	12,00
d. parents	1	4,00
e. No Response	8	32,00

Coca-Cola n = 14

	f	%
a. government	13	92,86
b. USLS-Balayan	1	7,14

Repolyo n = 1

	f	%
a. government	1	

Tangkong n = 9

	f	%
a. government	6	66,67
b. media	3	33,33

Table A11: Social Survey-Environment & Solid Waste Management

Appendix 6: Quickbird's characteristics

Launch	October 18, 2001, California	
Orbit	450km altitude; 93.5 minutes orbit time; 10:30am equator crossing time (descending); inclination 97.2° sun-synchronous	
Nominal swath width	16.5km at nadir	
On-board storage	128Gbit (approximately 57 scenes)	
Dynamic range	11 bits per pixel	
Resolution	Panchromatic	Multi-Spectral
	Basic: 0.61m at nadir, 0.72m at 25° off-nadir	Basic:2.44m at nadir, 2.88m 25°off-nadir
	Standard and orthorectified: resampled to 0.6m	Standard and orthorectified: resampled to 2.4/2.8 m
Spectral Bandwith	450-900 nanometers	Blue: 450-520 nanometers
		Green: 520-600 nanometers
		Red: 630-690 nanometers
		Near IR: 760-900 nanometers

Appendix 7: Confusion matrix, Supervised Classification (object-oriented classfication) Quickbird Image, Barangay 7

Thematic map classes \ Ground truth classes	**trees**	**gardens**	**water**	**roads**	**light roofs**	**other roofs**	**agricultural parcels**	**Sum**
Confusion Matrix								
trees	10	3	0	1	0	3	0	17
gardens	0	12	0	0	0	0		12
water	0	0	14	0	0	0	0	14
roads	0	0	0	7	0	1	0	8
light roofs	0	0	0	1	12	0	0	13
other roofs	0	0	1	0	0	5	0	6
agricultural parcels	0	3	0	4	0	0	25	32
unclassified	0	0	1	1	3	5	0	10
Sum	10	18	16	14	15	14	25	112
Accuracy								
User/contamination	0.588235	1	1	0.875	0.923077	0.833333,	0.78125	
Producer /omission error	1	0.666667	0.875	0.5	0.8	0.357143	1	
KIA Per Class	1	0.626667	0.857143	0.461538	0.773737	0.320755	1	
Totals								
Overall Accuracy	0.758929							
KIA	0.718514							

Appendix 8: Principal Component Analysis in Barangay 7

indiv	Elementary level	High school level	College level	No of siblings per hh (0-2y)	No of siblings 3-8y	No of siblings 9-14y	House and homelot rent	House and homelot owned	squatter
Coca-cola	0,17	0,54	0,29	0,35	0,88	0,02	0,02	0,74	0,45
Repolyo	0,54166667	0,38	0,08	0,33	0,67	0,00	0,04	0,54	0,83
Tangkong	0,39	0,52	0,09	0,36	0,64	0,00	0,00	0,54	0,93
Magnolia	0,16	0,46	0,38	0,31	0,55	0,05	0,07	0,66	0,54
a	0,03441747	0,48935539	0,47759416	0,48562642	0,9433676	0,17613424	0,00022398	0,85623538	0,49267024
b	0,22174291	0,24526125	0,3249927	0,41575404	0,79742704	0	0,50199276	0,82261219	0,44444921
c	0,39128899	0,26607433	0,54672753	0,17027183	0,79541132	0,13000862	0	0,82076436	0,39812577
d	0,38955027	0,30703256	0,3927643	0,40190496	0,95263487	0	0,27425771	0,6181593	0,52431908
e	0,45351608	0,86697774	0,39342337	0,2174914	1	0,26337017	0,115491	0,37391374	0,62053146
f	0,08628898	0,50844376	0,35187053	0,13095435	1	0,20975576	0	0,69202546	0,49257722
g	0,1180408	0,83651042	0,30394254	0,46966518	0,78740511	0	0	0,53763765	0,16334073
h	0,38339583	0,73451847	0,36544034	0,43156221	0,72818558	0,09400449	0	0,88841474	0,40619678
i	0	0,80811306	0,19495127	0,70714267	0,73121817	0,07022491	0,06677965	0,64826299	0,62731891
j	0,35942903	0,6509962	0,41364326	0,15279028	0,44257547	0,30131239	0	0,64176079	0,48658229
k	0,14773212	0,56820951	0,22170884	0,30393382	0,78507856	0	0,26254883	0,59337482	0,47595142
l	0,30966538	0,12863047	0	0,31952069	0,76853466	0,04015317	0,03872941	0,58514221	1
m	0,45181134	0,23328323	0,02592913	0,247305	0,48737074	0	0	0,79130005	0,52082591
n	0,27367593	0,58223872	0,30043934	0,56465789	0,41940711	0	0	0,40554677	0,94123125
o	0,40801105	0,22662541	0	0,28029317	0,5230392	0	0,05783659	0,46142432	1
p	0,24324475	0,25991816	0,22142988	0,59235922	0,46556125	0	0,04433174	0,49913489	0,99641633
q	0,42920279	0,40045143	0	0,29130556	0,90335512	0,07592528	0	0,47411209	0,78673465
r	0,37319754	0,37445665	0,32230353	0,46956272	0,67783305	0,0545093	0	0,44090303	0,92020097
s	0,87530493	0,51697514	0,21561164	0,46848314	0,68810178	0	0,04438019	0,5871037	0,81935739
t	0,5678074	0,36870602	0,2766562	0,43906814	0,40407989	0,4125532	0,08114794	0,47543941	0,80704514
u	0,39834367	0,83489066	0,23158526	0,27762278	0,55493103	0,26207698	0	0,22211631	0,67724483
v	0,29412073	0,42361795	0,24640951	0,1868881	0,368025	0	0,17711478	0,90552465	1
w	0,41914401	0,58356529	0,09195067	0,19445522	0,5495839	0	0	0,94348449	0,879646
x	0,53514379	0,59483814	0	0,21821483	0,76013504	0,35050868	0,44127582	0,28083657	0,78155238
y	0,74954562	0,74808796	0	0,64689748	0,52384866	0,12877748	0,55662966	0,34552063	1
z	0,22006731	0,81875075	0	0,2400191	0,82410948	0	0	0,57210058	0,51871416
aa	0,01773974	0,66500862	0,10237949	0	0,58080102	0	0	0,08236992	1
bb	0,17912458	0,80068638	0,18135395	0,50927297	0,71266224	0,01879095	0	0,49129989	0,77140304
cc	0,2336026	0,14013858	0,01009039	0,41707394	0,3821069	0	0	0,23945923	1
dd	0,38844725	0,53539192	0	0,32827839	0,6038319	0	0,21491488	0,58398222	0,94070176
ee	0	0,70005889	0,34196952	0,17255359	0,62252465	0	0,00533477	0,52434095	0,68526403
ff	0,18186424	0,02692356	0,52030602	0,41080242	0,62450044	0,10431563	0,09788119	0,82440508	0,47817881
gg	0	0,57952294	0,51500112	0,4241851	0,44083607	0,12892813	0,0136281	0,5277191	0,60089784
hh	0	0,6108108	0,15924593	0,49209071	0,50915252	0,25486958	0	0,99631632	0,00234048
ii	0,08554324	0,17703246	0,40879924	0,26803378	0,6791794	0,00417502	0,26374395	0,80413639	0,46838123
jj	0	0,51738234	0,71555815	0,48706611	0,40005507	0,16551368	0,400007	0,58377916	0,49230031
kk	0,1875613	0,15486745	0,48807612	0,22119587	0,46690678	0,08736736	0	0,77762736	0,7507604
ll	0,59363545	0,53391663	0,36920774	0,22030304	0,61169435	0	0	0,52649123	0,5282858
mm	0,17091021	0,39551015	0,60390735	0,2689154	0,29083842	0,2538498	0,21001975	0,57248908	0,64779439
nn	0	0,47359166	0,72303764	0,35206898	0,12969984	0,17897671	0,15144022	0,90490764	0,64475102

Table A12: PCA simulation (table 1/2)

indiv	house in cement	house in wood, woodcement	house in light materials	garbage sell	garbage and segregated waste burning, burying, throw away,	garbage and segregated waste: compost, recycle, garbage can, eco-center	segregation Y	motivation for SWM:health,	motivation for swm: money	motivation for swm: WM
Coca-cola	0	0,97959184	0,02040816	0,15384615	0,63461538	0,21153846	0,28571429	0	0,57142857	0,42857143
Repolyo	0	1	0	0	0,875	0,125	0,08333333	0	1	0
Tangkong	0,03571429	0,85714286	0,10714286	0,04	0,4	0,56	0,32142857	0,6	0,2	0,2
Magnolia	0,15	0,85	0	0,13793103	0,44827586	0,4137931	0,40983607	0,58333333	0,33333333	0,08333333
a	0	0,75469658	0	0	0,75977247	0,26018537	0,0774972	0,21109829	0,55174171	0,83553706
b	0,04018476	0,86032876	0	0,49441872	0,63502941	0,33628037	0,2784059	0	0,65485898	0,24657684
c	0,15304945	1	0	0,01468376	0,95654999	0	0,39987082	0	0,56193417	0,43050704
d	0	0,82966931	0	0,03733367	0,65081048	0,26535744	0,23992096	0,19199427	0,68482437	0,18290821
e	0	1	0	0	0,52630051	0,42522047	0,53636749	0	0,35573002	0,17684158
f	0,09647473	0,99406971	0,2344328	0,15347053	0,86239604	0,17213561	0,32464043	0	0,09360797	0,23419009
g	0	0,9925717	0,01090564	0	0,52676399	0,09031337	0,20583047	0,12371961	0,3424561	0,48032609
h	0	0,83280238	0,03838579	0	0,5757703	0,00414557	0,13742426	0	0,66749121	0,32404409
i	0,26524651	1	0	0,25353446	0,6379764	0,28732122	0,28234729	0	0,6286477	0,2555537
j	0	1	0	0,45939069	0,80528334	0,17738529	0,3402602	0	0,43240878	0,16657595
k	0,30947788	1	0	0	0,76777464	0	0,32892538	0,23235556	0,99445502	0,16097441
l	0,03698619	1	0	0,29778994	0,85668625	0	0,1851877	0	0,93174254	0,14975042
m	0,0341354	0,70801486	0,35904542	0	1	0,13347083	0	0	0,77042788	0
n	0	0,96615326	0	0,06209226	0,75715653	0,00667158	0,17284057	0	1	0,16390033
o	0	1	0,24178896	0,21050505	0,93390577	0,54759908	0	0,06596395	0,98058414	0
p	0,06309688	0,98378529	0,07981017	0	0,98285523	0,32397886	0	0,1498875	0,77205716	0,07331874
q	0	0,54909637	0	0,22270203	0,68756214	0,42941558	0	0,08135683	1	0
r	0	0,82575223	0	0,05581307	0,67294195	0,05306296	0	0	1	0,14894467
s	0	1	0,21647535	0,09052267	1	0	0,39662536	0	1	0,35644715
t	0	0,58311544	0,0475194	0	0,68335619	0	0	0	0,7412359	0,26888573
u	0,15219654	0,82609315	0,19650839	0,0240281	0,22212707	0,85535763	0,63161164	0,73480076	0,17705005	0,19626366
v	0,05668918	0,92038006	0	0,21294168	0,33535829	0,67449449	0,68369965	0,1488093	0,27704653	0,04941772
w	0,3518135	0,84482383	0,06253582	0	0,40084633	0,30185356	0,46059858	0,4778061	0,24589798	0
x	0,16444643	1	0	0,29691883	0,37039436	0,75831109	0	0,66338546	0,34347753	0,05814867
y	0	0,61737521	0,28227544	0,10765982	0,32946916	0,26918184	0,21608846	0,86683331	0,17077241	0,03653373
z	0,21143822	0,84089171	0	0	0,37757662	0,74876744	0,11813876	0,61211155	0,46949782	0
aa	0	0,99271412	0	0,10752547	0,73612864	0,74007175	0,55315587	0,78140616	0,13542293	0,08929987
bb	0,61254324	0,73156037	0,24691661	0,43388425	0,40226787	0,63073566	0,38028474	0,47973178	0,4425181	0,62700269
cc	0,13797376	0,51758476	0,52324875	0	0,26914677	0,01675388	0,53570918	0,73023135	0,08500494	0,31509557
dd	0	0,58837582	0,07543808	0	0,38719009	0,8736375	0,59468571	0,73907098	0	0,49482191
ee	0	0,80847584	0,0808359	0,62175879	0,34124806	0,13785919	0,44094065	0,84245963	0,01874017	0
ff	0,17560821	0,49146803	0	0,52934932	0,36207281	0,36494709	0,48537732	0,72358906	0,14227351	0
gg	0,2206725	0,67640973	0	0,23212674	0,71973887	0,36097044	0,26296316	0,16332885	0,48082581	0
hh	0,25128388	0,73740695	0	0	0,81610702	0,34653374	0,17207029	0,3829487	0,29376947	0,33826083
ii	0,28728144	0,69362555	0	0,07692068	0,81275951	0,46573879	0,22802492	0,80099311	0,70342171	0,16505108
jj	0,25541231	0,75026766	0,1272932	0	0,32716916	0,61778109	0,47200572	0,44861467	0,2945406	0,43811445
kk	0,3429454	0,85293662	0	0	0,22399062	0,31114975	0,17534863	0,71632246	0,502472	0,55607203
ll	0	0,70042064	0,2366034	0,31208566	0,37488886	0,47893959	0,37871563	0,29585731	0,20259821	0,33846352
mm	0,04604518	0,75611313	0	0,32275956	0,64853518	0,15391516	0,61979428	0,53928369	0,22468828	0
nn	0,06693123	1	0,23876369	0,18130813	0,1826674	0,58184411	0,64887048	0,53755094	0,42352131	0,16248774

Table A13: PCA simulation (table 2/2)

Statistiques simples :

Variable	Observations c	données ma	s données ma	Minimum	Maximum	Moyenne	Ecart-type
Elementary level	44	0	44	0,000	0,875	0,345	0,234
High school level	44	0	44	0,098	0,997	0,470	0,203
College level	44	0	44	0,000	0,790	0,251	0,195
No of siblings per hh (0-2y)	44	0	44	0,000	0,780	0,353	0,183
No of siblings 3-8y	44	0	44	0,299	1,000	0,644	0,175
No of siblings 9-14y	44	0	44	0,000	0,492	0,059	0,106
House and homelot rent	44	0	44	0,000	0,494	0,129	0,126
House and homelot owned	44	0	44	0,034	1,000	0,631	0,219
squatter	44	0	44	0,225	1,000	0,663	0,213
house in cement	44	0	44	0,000	0,370	0,101	0,120
house in wood, woodcement	44	0	44	0,525	1,000	0,860	0,148
house in light materials	44	0	44	0,000	0,364	0,088	0,104
garbage sell	44	0	44	0,000	0,456	0,112	0,134
garbage and segregated wast	44	0	44	0,000	0,881	0,297	0,202
garbage and segregated wast	44	0	44	0,045	1,000	0,579	0,247
segregation Y	44	0	44	0,000	0,687	0,315	0,230
motivation for SWM:health,	44	0	44	0,000	0,798	0,298	0,290
motivation for swm: money	44	0	44	0,000	1,000	0,529	0,310
motivation for swm: WM	44	0	44	0,000	0,721	0,219	0,210

Table A14: PCA-simple statistics

Variables	Elementary level	High school level	College level	No of siblings per hh (0-2y)	No of siblings 3-8y	No of siblings 9-14y	House and homelot rent	House and homelot owned	squatter	house in cement	house in wood, woodcement	house in light materials	garbage sell
Elementary level	1	-0,116	-0,305	-0,052	-0,078	-0,265	-0,249	-0,335	0,473	-0,009	0,303	0,006	-0,212
High school level	-0,116	1	-0,128	0,106	0,351	0,014	0,097	0,183	-0,181	0,047	-0,392	0,179	0,159
College level	-0,305	-0,128	1	-0,022	-0,160	0,177	-0,071	0,211	-0,198	0,285	-0,136	-0,210	0,298
No of siblings per hh (0-2y)	-0,052	0,106	-0,022	1	-0,035	-0,030	0,108	0,040	-0,011	0,063	0,025	0,039	0,231
No of siblings 3-8y	-0,078	0,351	-0,160	-0,035	1	-0,010	0,161	0,227	-0,271	-0,005	-0,302	-0,037	-0,141
No of siblings 9-14y	-0,265	0,014	0,177	-0,030	-0,010	1	-0,097	-0,023	-0,324	0,061	-0,335	0,210	0,034
House and homelot rent	-0,249	0,097	-0,071	0,108	0,161	-0,097	1	0,061	-0,204	-0,046	-0,169	0,100	-0,084
House and homelot owned	-0,335	0,183	0,211	0,040	0,227	-0,023	0,061	1	-0,382	0,029	-0,010	0,007	0,293
squatter	0,473	-0,181	-0,198	-0,011	-0,271	-0,324	-0,204	-0,382	1	0,120	0,246	0,016	-0,223
house in cement	-0,009	0,047	0,285	0,063	-0,005	0,061	-0,046	0,029	0,120	1	-0,075	-0,205	-0,112
house in wood, woodcement	0,303	-0,392	-0,136	0,025	-0,302	-0,335	-0,169	-0,010	0,246	-0,075	1	-0,477	0,003
house in light materials	0,006	0,179	-0,210	0,039	-0,037	0,210	0,100	0,007	0,016	-0,205	-0,477	1	-0,009
garbage sell	-0,212	0,159	0,298	0,231	-0,141	0,034	-0,084	0,293	-0,223	-0,112	0,003	-0,009	1
garbage and segregated was	-0,051	-0,014	-0,047	0,027	0,250	-0,232	0,287	0,368	-0,106	-0,377	0,215	0,035	0,157
garbage and segregated was	0,498	-0,055	-0,281	-0,132	-0,020	-0,174	-0,354	-0,249	0,475	0,048	0,035	0,167	-0,254
segregation Y	-0,481	-0,034	0,333	-0,046	0,061	0,161	0,088	0,146	-0,430	0,159	-0,180	-0,077	0,073
motivation for SWM:health,	-0,132	0,274	0,123	0,006	0,095	0,126	-0,087	-0,093	0,119	0,639	-0,443	0,128	-0,243
motivation for swm: money	0,145	-0,441	0,065	-0,030	-0,256	-0,081	-0,015	-0,113	-0,025	-0,332	0,366	-0,134	0,235
motivation for swm: WM	-0,232	0,217	-0,101	0,198	-0,052	0,109	0,242	-0,016	-0,114	-0,086	-0,016	-0,029	0,378

Les valeurs en gras sont significativement différentes de 0 à un niveau de signification alpha=0,05

Table A15: Pearson correlation matrix (table 1/2)

Variables	garbage and segregated waste burning, burying, throw away,	garbage and segregated waste: compost, recycle, garbage can, eco-center	segregation Y	motivation for SWM:health,	motivation for swm: money	motivation for swm: WM
Elementary level	-0,051	**0,498**	**-0,481**	-0,132	0,145	-0,232
High school level	-0,014	-0,055	-0,034	0,274	**-0,441**	0,217
College level	-0,047	-0,281	**0,333**	0,123	0,065	-0,101
No of siblings per hh (0-2y)	0,027	-0,132	-0,046	0,006	-0,030	0,198
No of siblings 3-8y	0,250	-0,020	0,061	0,095	-0,256	-0,052
No of siblings 9-14y	-0,232	-0,174	0,161	0,126	-0,081	0,109
House and homelot rent	0,287	**-0,354**	0,088	-0,087	-0,015	0,242
House and homelot owned	**0,368**	-0,249	0,146	-0,093	-0,113	-0,016
squatter	-0,106	**0,475**	**-0,430**	0,119	-0,025	-0,114
house in cement	**-0,377**	0,048	0,159	**0,639**	**-0,332**	-0,086
house in wood, woodcement	0,215	0,035	-0,180	**-0,443**	**0,366**	-0,016
house in light materials	0,035	0,167	-0,077	0,128	-0,134	-0,029
garbage sell	0,157	-0,254	0,073	-0,243	0,235	**0,378**
garbage and segregated waste burning, burying, throw away,	**1**	-0,243	0,058	**-0,540**	0,130	0,146
garbage and segregated waste: compost, recycle, garbage can, eco-center	-0,243	**1**	-0,254	0,228	-0,065	**-0,359**
segregation Y	0,058	-0,254	**1**	0,175	-0,146	0,078
motivation for SWM:health	**-0,540**	0,228	0,175	**1**	**-0,711**	-0,082
motivation for swm: money	0,130	-0,065	-0,146	**-0,711**	**1**	-0,159
motivation for swm: WM	0,146	**-0,359**	0,078	-0,082	-0,159	**1**

Table A16: Pearson correlation matrix (table 2/2)

Valeurs propres :

	F1	F2
Valeur propre	3,432	3,030
Variabilité (%)	18,061	15,949
% cumulé	18,061	34,010

Table A17: Eigen values

Corrélations entre les variables et les facteurs :

	F1	F2
Elementary level	0,763	0,076
High school level	-0,410	0,301
College level	-0,377	-0,031
No of siblings per hh (0-2y)	-0,139	-0,084
No of siblings 3-8y	-0,315	0,129
No of siblings 9-14y	-0,379	0,192
House and homelot rent	-0,352	-0,193
House and homelot owned	-0,486	-0,244
squatter	0,710	0,233
house in cement	-0,112	0,573
house in wood, woodcement	0,519	-0,506
house in light materials	-0,095	0,228
garbage sell	-0,340	-0,419
garbage and segregated wast	-0,144	-0,633
garbage and segregated wast	0,619	0,430
segregation Y	-0,562	0,030
motivation for SWM:health,	-0,204	0,905
motivation for swm: money	0,334	-0,676
motivation for swm: WM	-0,365	-0,216

Table A18: Correlation matrix

Coordonnées des observations :

Observation	F1	F2
Coca-cola	-0,723	-1,836
Repolyo	2,892	-1,182
Tangkong	1,276	1,744
Magnolia	-0,938	0,757
a	-2,508	-1,726
b	-1,391	-0,891
c	0,192	-1,982
d	-2,076	-1,295
e	-1,788	-3,044
f	-0,967	-2,337
g	-0,266	-1,325
h	-0,272	-1,998
i	-2,896	-2,438
j	-2,242	-2,145
k	2,440	-1,138
l	3,936	-1,092
m	1,129	-1,126
n	2,903	-1,386
o	1,277	0,890
p	2,342	-1,262
q	1,900	-1,549
r	3,827	-0,711
s	1,119	-2,073
t	-0,536	-0,635
u	-0,541	3,665
v	-1,323	1,461
w	2,373	3,151
x	2,557	1,132
y	-0,501	2,484
z	1,151	3,128
aa	-0,666	0,748
bb	-0,072	1,561
cc	0,935	2,551
dd	1,041	0,765
ee	-1,316	0,518
ff	0,062	0,453
gg	0,682	0,984
hh	-3,154	1,410
ii	-3,005	0,746
jj	-1,131	0,100
kk	-0,575	-0,598
ll	-1,550	2,036
mm	-0,951	0,882
nn	-2,643	2,604

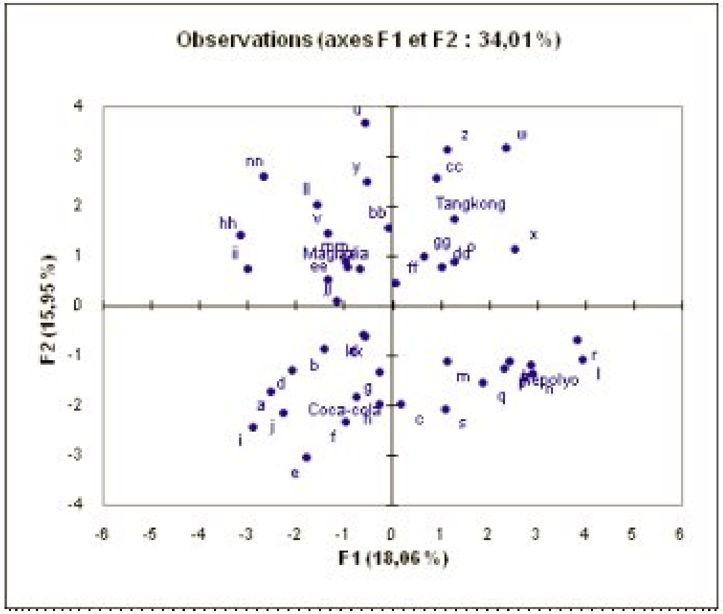

Table A19: Observation coordinates

Appendix 9a: Profitability survey (form)

Name of Respondent: __________________________ Respondent No. ______
Position in the family: __________________________ Vacant Lot No.________

I. Do you have a regular income? _____Yes ____No
IF YES (answer all questions)
IF NO (go straight to II)
I.1.Where does your main income come from?
____ Agriculture
____ Not from agriculture (go straight to question II)

If AGRICULTURE
I.1.1.Which part of your HH budget comes from agriculture? (Encircle answer)
100%
Less than 100% but more than 50%
50%
Less than 50%
I.1.2.Where are you working?
Barangay 7
Outside Barangay 7 but within Bacolod City
Outside Bacolod City
IF OUTSIDE BACOLOD
I.1.2.1.Would you prefer to work in Barangay 7?
____Yes
____No

II. What part of your income would you like to earn from UA? (From 0% (10) to 100%) ____________________

III How do you evaluate your own agricultural skill? (From 0% to 100%) ___________

IV. What product would you like to plant if you have a garden?
___ Vegetables
____ Crops
____Others: Pls Specify: _________________

V. In your opinion what are the possible threats to UA implementation?
____Permit to cultivate
____Land Ownership
____Natural risks (flood, diseases, …)
____Accessibility
____Lack of buyers
____Inflation

____Others. Pls Specify.

VI. Would you prefer to use inorganic or organic fertilizer?
____Organic
____Inorganic

VI.1. What's the reason for your choice?
____Cheap cost
____Environment friendly
____Others. Pls Specify:____________________

VII. Do you think that agriculture is the best use for the plot of land?
____YES (1)
____NO: What do you suggest?
Housing
Commerce or Business
Others. Pls Specify:______________

VIII. Which transportation would you use between the production and selling places?
_____Pedicab
_____Jeepney
_____ Others. Pls Specify:________________
_____ No Transportation Needed

IX. How do you evaluate the potential of the plot of land for UA? (1 is the best, 10 the worst)
____Good fertility from 1 to 10?
____flood from 1 to 10?
____Others. Please Specify: _____________ Rate from 1 to 10?

Appendix 9b: Profitability survey (answers)

PRODUCTION VALUE

Parcels	Name of the respondents	Skills	Chosen product (vef, crops, flowers, fruits): 1. Vegetables	2. Crops	3.others (flowers..	4. Fruits	SCORE	NORMALIZED SCORE	agri=best use for the parcel: Yes	NORMALIZED SCORE	Potential of the parcels (fertility, flood…): 1. Good Fertility (*7)	2. Flood (*3)	SCORE	WEIGHTED NORMALIZED SCORE	Proximity of non-workers (based on regularity of income): Regular Income 1.Yes	2. No	NORMALIZED SCORE
6	Violeta P. Villacarillo	8,00	10,00	0,00	1	0			10		8	4		68	1		
6	Evelyn Nemenzo	5,00	10,00	5,00	0	0			10		4	8		52	1		
6	Rodina Subaldo	10,00	10,00	5,00	0	0			10		9	1		66		10	
6	Mercy Entiero	8,00	10,00	5,00	0	0			10		10	4		82		10	
6	Nelly Datu-on	8,00	10,00	5,00	1	0			10		10	1		73	1		
6	Ianna Marie Chua	10,00	10,00	5,00	1	0			10		10	1		73		10	
6	Orllenny Lim	10,00	10,00	5,00	1	0			10		10	1		73	1		
total parcel 6		0,84	10,00	4,29	0,57	0,00	104,00	0,71	10	1	0,87	0,29	81	0,70			0,44
9	Jerardo Escala	10,00	10,00	5,00	0	0			10		9,00	6,00		81		10	
9	Romeo Magbanua	8,00	10,00	0,00	0	0			10		9,00	6,00		81		10	
9	Naysie	5,00	10,00	5,00	1	0			10		6,00	6,00		60	1		
9	Erlinda Intis	10,00	10,00	5,00	1	0			10		6,00	8,00		66	1		
9	Alfonso Umbao	10,00	10,00	5,00	0	0			10		10,00	1,00		73		10	
total parcel 9		0,86	10,00	4,00	0,400	0,00	72,00	0,69	10	1	0,80	0,54	67	0,72			0,58
1	Teresita Abello	9,00	10,00	5,00	0	0			10		9,00	8,00		87	1		
1	Lovemin Maquilan	10,00	10,00	5,00	0	0			10		10,00	9,00		97	1		
1	Lydia Duatin	10,00	10,00	5,00	0	0			10		9,00	10,00		93		10	
1	Aneta Duatin	9,00	10,00	5,00	0	0			10		10,00	10,00		100		10	
total parcel 1		0,95	10,00	5,00	0,000	0,00	60,00	0,71	10	1	0,95	0,93	75	0,94			0,50
5	Nelyn Blanza	5,00	10,00	5,00	0	0			10		6,00	8,00		66		10	
5	Teresita Arac	10,00	10,00	5,00	1	5			10		9,00	10,00		93		10	
5	Lydia Cuevas	10,00	10,00	5,00	0	0			10		9,00	6,00		81		10	
5	Jboy Malunda	8,00	10,00	5,00	0	0			10		9,00	8,00		87		10	
5	Celestina Casas	10,00	10,00	5,00	0	0			10		10,00	2,00		76		10	
5	Jupela Penuela	5,00	10,00	5,00	0	0			10		10,00	6,00		88		10	
5	Rosalinda Cuenca	10,00	10,00	5,00	1	0			10		10,00	10,00		100	1		
total parcel 5		0,83	10,00	5,00	0,29	0,71	112,00	0,76	10	1	0,90	0,71	113	0,84			0,79
10	Manuel Lausa	10,00	10,00	5,00	0,00	0,00			10		6,00	10,00		72	1		
10	Flor Magdayao	5,00	10,00	0,00	0,00	0,00			10		9,00	10,00		93	1		
10	Rosario Mogato	8,00	10,00	5,00	0,00	0,00			10		9,00	10,00		93		10	
10	Bearhoney Florentino	8,00	10,00	5,00	0,00	0,00			10		9,00	10,00		93		10	
total parcel 10		0,78	10,00	3,75	0,00	0,00	55,00	0,65	10	1	0,83	1,00	73	0,88			0,5
3	Arly Fernandez	5,00	10,00	5,00	0,00	0,00			10		10	10		100		10	
3	Leah Pabillo	8,00	10,00	5,00	0,00	0,00			10		10	10		100	1		
3	Placida Duatin	10,00	10,00	5,00	0,00	0,00			0		10	10		100	1		
3	Elena Duatin	9,00	10,00	5,00	0,00	0,00			10		10	10		100	1		
3	Catalina Querido	10,00	10,00	0,00	0,00	0,00			10		10	10		100		10	
3	Nilda Querido	8,00	10,00	5,00	0,00	0,00			10		10	10		100		10	
total parcel 3		0,83	10,00	4,17	0,00	0,00	85,00	0,67	8,33	0,83	1	1	120	1			0,5

NB: MAXIMUM= 10, MINIMUM=0
ALL SCORES ARE NORMALIZED [0,1]

Table A20: Production value

PRODUCTION COST

Parcels	Name of the respondents	Threats (permit, natural risks, access)				Types of fertilizers (in or organic)			Transport mean (pedicab, jeepney, others or no mean)			
		1. Permit to Cultivate (/10)	2. Land Ownership (/10)	3. Accessibility (/5)	NORMALIZED SCORE	1. Organic	2. Inorganic	NORMALIZED SCORE	1. Pedicab	2. Jeepney	3. No transpo needed	NORMALIZED SCORE
6	Violeta P. Villaca	0	0	5		0	10		0	0	1	
6	Evelyn Nemenzo	0	10	5		1	0		0	0	1	
6	Rodina Subaldo	0	10	0		1	0		2	0	0	
6	Mercy Entiero	0	10	0		1	0		2	0	0	
6	Nelly Datu-on	10	10	0		1	0		2	0	0	
6	Ianna Marie Chu	0	10	0		1	0		2	0	0	
6	Orllenny Lim	0	10	0		1	0		2	0	0	
		1,43	8,57	1,43	0,46	0,86	1,43	0,21	1,43	0,00	0,29	0,21
9	Jerardo Escala	0	0	0		1	0		0	0	1	
9	Romeo Magbanu	0	0	0		1	0		2	0	0	
9	Naysie	0	10	0		1	0		2	0	0	
9	Erlinda Intis	0	10	5		1	0		2	0	0	
9	Alfonso Umbao	10	10	0		1	0		2	0	0	
		2,00	6,00	1,00	0,36	1,00	0,00	0,09	1,60	0,00	0,20	0,23
1	Teresita Abello	0	10	5		1	0		2	0	0	
1	Lovemin Maquila	0	10	5		1	0		2	0	0	
1	Lydia Duatin	0	10	0		1	0		0	0	0	
1	Aneta Duatin	0	10	0		1	0		0	0	1	
		0	10	2,5	0,5	1	0	0,09	1	0	0,25	0,16
5	Nelyn Blanza	0	10	5		1	0		2	0	0	
5	Teresita Arac	0	10	5		1	0		0	5	0	
5	Lydia Cuevas	0	10	5		1	0		0	0	1	
5	Jboy Malunda	0	10	5		1	0		0	0	1	
5	Celestina Casas	0	0	0		1	0		0	0	1	
5	Jupela Penuela	0	0	0		0	10		0	0	1	
5	Rosalinda Cuen	10	10	0		1	0		0	5	0	
		1,43	7,14	2,86	0,46	0,86	1,43	0,21	0,29	1,43	0,57	0,29
10	Manuel Lausa	0	10	0		1	0		2	0	0	
10	Flor Magdayao	0	10	0		1	0		2	0	0	
10	Rosario Mogato	0	10	0		1	0		2	0	0	
10	Bearhoney Flore	0	10	0		1	0		2	0	0	
		0	10	0	0,4	1	0	0,09	2	0	0	0,25
3	Arly Fernandez	0	0	0		1	0		0		1	
3	Leah Pabillo	0	10	0		1	0		2			
3	Placida Duatin	0	10	0		0	10		0		1	
3	Elena Duatin	10	10	0		1	0		0	5		
3	Catalina Querido	10	10	0		1	0		0		1	
3	Nilda Querido	10	10	0		1	0		0		1	
		5	8,33	0	0,53	0,83	1,67	0,23	0,33	5	1	0,23

NB: MAXIMUM COST= 10, MINIMUM COST=1; 0 indicates that the variable is not a concern for the parcel
ALL SCORES ARE NORMALIZED [0,1]

Table A22: Production cost

cost-->high is worst (high score, worst access)

	mean distances to Water resources	Normalised water access	mean of distances from all markets per parcel (m)	Normalised markets access	mean of distances from all pathways (m)	Normalised pathways access	
1	329,563	0,469894729	1769,008	0,101035032	270,63	0,291429914	0,013835877
3	235,209	0,228750987	1784,62	0,204617834	228,111	0,087551726	0,004097993
5	536,981	1	1753,78	0,01	418,403	1	0,01
6	154,099	0,021455388	1861,75	0,716361465	282,928	0,350398703	0,005385563
9	145,704	0,01	1815,77	0,411292463	209,852	0,01	4,11292E-05
10	268,94	0,314958457	1904,5	1	384,05	0,835277702	0,263077776
	145,704	MIN	1753,78	MIN	209,852	MIN	
	536,981	MAX	1904,5	MAX	418,403	MAX	
	391,277	ECART	150,72	ECART	208,551	ECART	

Table A24: Production cost (table 3/3)

Parcel	Production Value	Production Cost	Profitability
parcel 9	0,24772	0,00000	0,24772
parcel 6	0,18318	0,00011	0,18308
parcel 1	0,31978	0,00010	0,31968
parcel 5	0,42224	0,00027	0,42197
parcel 3	0,23424	0,00011	0,23412
parcel 10	0,22264	0,00239	0,22025

Table A25: Profitability value per plot

Appendix 10: Social Survey (Barangay Bugo)

Zone	population	main occupation	Skills	time for gardening act	aware of AG	aware of ISWM	materials used for collection	annual income (in PhP)	income per month (in PhP)
1 upper	more or less 3000	Public, Private and housekeeper	Carpenter Mechanic, Welder, Plumber, Mason		yes	yes	sack, throw in seashore & creek side		729,1041667
1 proper	almost 3,000	Public, Private and housekeeper	Carpenter, Mechanic, Welder, Plumber, Mason	2 hrs./day	yes	yes	grocery bag (cellophane), rice sack		729,1041667
3		Del Monte Phils.			no	yes	grocery bags, sacks	10,000-19,999	833,25
4	1452	Del Monte Phils, Contract worker	teachers, seaman, nurse, midwife	once a week	yes	yes	grocery bags, sack		729,1041667
5		Del Monte worker	supervisor, skilled driver, mechanic, machinist, electrician, canning, carpenter	n/a	no	yes	grocery bags, sack returnable	20,000-29,999/150000-249999	833,25
6		DMPI	doctor, engineers, teachers, driver, nurses, contractor, seaman, pharmacist		no	yes	grocery bag, sack		729,1041667
7 VTS phase 2	ask brgy health	government, private, nestle, DMPI	can't identify	2 hrs/week	yes	yes	sack	ask info in brgy	729,1041667
7 VTS Phase 3	inquire P3 HA Brgy hall		welder - 10%, mechanic 15%, mason 20%, technician 8%, electrician	1-2 hrs/day	yes	yes	polyethelene bags, grocery bags	none	729,1041667
8 Suntingon	1074	farmer, firewoods gatherer, carpenter	drivers, farmers, firewood gatherer	any hour of day	yes	no	sack	10,000-19,999	833,25
8 Kilhapon	80	farmer	farmer, mason, carpenter	6 hrs/week	no	no	sack, sungon	under 10,000	416,6666667

Table A26: Social Survey in Barangay Bugo

Appendix 11:PCA in Barangay Bugo

indiv	No. of house	population	ratio of employment	aware of AG	aware of SW	income per month	number of children	skills	people density
1	0,20600162	0,20842617	0,202380952	1	1	0,75	0,149553571	0,08791209	0,07420381
3	0,24412003	0,30078995	0,339285714	0,001	1	1	0,229910714	0,39943093	0,404652884
4	0,21411192	0,22361758	0,339285714	1	1	0,75	0,176339286	1	1
5	0,24168694	0,26189994	0,339285714	0,001	1	1	0,34375	0,11302983	0,299710786
6	1	1	0,339285714	0,001	1	0,75	1	0,58791209	0,152163335
72	0,06974858	0,05752481	0,339285714	1	1	0,75	0	0,39943093	0,168839718
73	0,19951338	0,2015394	1	1	1	0,75	0,232142857	0	0,233381125
81	0,18572587	0,20295726	0,154761905	1	0,001	1	0,435267857	0,90842491	0,00926652
82	0	0	0	0,001	0,001	0	0,066964286	0,76190476	0
a	0,33039344	0,02896753	0,383999416	0,81551366	1	0,328780801	0	0,18011792	0,142199826
b	0,16544291	0	0,201181704	0,71955088	0,69755464	0,57342798	0	0,16476904	0,076131691
c	0,26720721	0,38447778	0	0,73023388	0,83957694	0,924513531	0,743096589	0,02357154	0,072185813
d	0,29606013	0,43284095	0,271076736	0,76064297	1	0,542080819	0	0,16186126	0
e	0,2802662	0,46650144	0,278469261	1	1	0,63471936	0,047012796	0,52707745	0
f	0,21186929	0,17230583	0,443319859	0,01517036	0,90214021	0,99455959	0,45140716	0,62753842	0,323951338
g	0,02318236	0,19199527	0,010901525	0,39774335	0,92909742	0,795973669	0,555244629	0,30657794	0,378540529
h	0,20332292	0,34967929	0,535803459	0,21346908	1	1	0,252869411	0,09969391	0,624548212
i	0,16392289	0,57434596	0	0	0,78166761	0,744749806	0	0,33985128	0,721859937
j	0,29371594	0,27072414	0,547173911	0,20537812	1	1	0,602078545	0,13022707	0,342434077
k	0,08347483	0,25913323	0,534806596	0,90812654	1	0,62096796	0,249884273	1	1
l	0,51884642	0,43022844	0,233314536	1	1	0,750454176	0,025714772	0,7345585	1
m	0,3011375	0,31247472	0,216027584	0,99228064	0,9709105	0,74481145	0	0,71132702	1
n	0,30780599	0,17140763	0,351227725	0,93261743	1	0,977995924	0,161826144	0,47136574	0,98433282
o	0,27474384	0,35926938	0,596635033	1	1	0,636552978	0	0,87840936	1
p	0,59086474	0,40884413	0,53875604	0,04468751	0,88394869	1	0,477625281	0,10380692	0,2978112
q	0,51301015	0,05676505	0,589058469	0,07338626	1	1	0,100922392	0,20191526	0,594186078
r	0,20823797	0,40897443	0,442081413	0,20568231	1	1	0,261507514	0,18747936	0,387963518
s	0,22472071	0,32679629	0,226833469	0	1	1	0,425688855	0,07997688	0,560818592
t	0,47418848	0,18933363	0,522703995	0	1	0,661781911	0,412028772	0,34653917	0,176083987
u	1	0,76579654	0,402570214	0	0,7255198	0,644056027	1	0,79669775	0,059063793
v	0,70880787	1	0,481766016	0	0,87514042	0,968951328	0,828116106	0,48064813	0,265765558
w	1	1	0,325590789	0,27599302	0,90136259	0,972295211	1	0,60108259	0,342370639
x	1	0,7762538	0,524615683	0	0,98484366	0,579792138	1	0,5494646	0,200520356
y	0,47004205	1	0,680665605	0	1	1	0,360779108	0,19643899	0,219721341
z	0	0,13830191	0,107398186	1	0,95944822	0,935125107	0	0,30896795	0,0383528
aa	0	0,03872828	0	1	0,70250058	0,544148403	0,061334349	0,57827858	0
bb	0	0,21078496	0,353969329	0,92932325	0,83441566	0,708039508	0	0,75621858	0,321295762
cc	0,06856798	0,02385234	0,328910589	1	1	0,730639844	0,22023801	0,09937173	0,589934207
dd	0	0	0,232423625	1	1	0,711434849	0	0,61870468	0,228827786
ee	0,34447199	0,15727384	1	0,71166421	0,9212795	0,62504813	0,522629028	0,19326126	0,56510033
ff	0,66822475	0,0140951	1	0,83935734	0,89316524	0,793241512	0,0391817	0	0,197447746
gg	0,09229873	0,04349258	0,670187973	0,77873769	0,91059961	0,606189074	0,074442888	0	0,424105565
hh	0,23618899	0,33493037	0,991500656	0,61584101	0,83084272	0,813230135	0,324278845	0	0,700260222
ii	0,17972094	0,23305884	1	0,8605513	1	0,54241486	0,196915774	0,31573837	0,218032661
jj	0,24575996	0,33291565	0,069718453	1	0,21137542	1	0,451360329	0,87565659	0
kk	0,35983851	0,37806501	0	1	0,09596857	1	0,286586184	0,90915702	0
ll	0	0,52913459	0,066356789	1	0,30501474	1	0,524805202	0,7808881	0,317972298
mm	0,16494388	0,262798	0,434764425	0,91170196	0,47910074	0,907541119	0,316625899	1	0
nn	0,16766747	0,30741855	0,237462243	0,6721864	0,33266309	1	0,529765629	1	0,30723294
oo	0,01141879	0,00140807	0,039910779	0,01818898	0	0	0,285505597	0,54190815	0,037896321
pp	0	0,12326203	0,018804045	0	0,06147765	0	0,153241309	0,94416964	0,144551312
qq	0	0,15157029	0,145860582	0,20312192	0	0,000740001	0,359680202	0,6840304	0,051981803
rr	0,15176603	0,13393153	0	0	0,01445192	0,090957048	0,11198283	0,95305495	0
ss	0	0,27337654	0,138114005	0,06866708	0,28902305	0,082396871	0,085996197	0,97828063	0,108703592

Table A27: PCA simulation in Barangay Bugo

Variable	Observations	c données mas	données ma	Minimum	Maximum	Moyenne	Ecart-type
No. of househ	54	0	54	0,000	1,000	0,277	0,269
population	54	0	54	0,000	1,000	0,305	0,265
ratio of emplo	54	0	54	0,000	1,000	0,356	0,282
aware of AG	54	0	54	0,000	1,000	0,535	0,434
aware of ISW	54	0	54	0,000	1,000	0,765	0,350
income per m	54	0	54	0,000	1,000	0,721	0,299
number of chi	54	0	54	0,000	1,000	0,299	0,287
skills	54	0	54	0,000	1,000	0,476	0,334
density	54	0	54	0,000	1,000	0,322	0,310

Table A28: Simple statistics

Variables	lo. of househol	population	io of employm	aware of AG	ıware of ISWI	come per mon	ımber of childr	skills	density
No. of househ	**1**	**0,702**	**0,322**	**-0,318**	**0,319**	**0,284**	**0,646**	-0,094	0,025
population	**0,702**	**1**	0,068	**-0,335**	0,185	**0,337**	**0,666**	0,086	0,029
ratio of emplo	**0,322**	0,068	**1**	0,047	**0,518**	0,225	0,073	**-0,445**	**0,278**
aware of AG	**-0,318**	**-0,335**	0,047	**1**	0,119	0,166	**-0,420**	0,095	0,146
aware of ISW	**0,319**	0,185	**0,518**	0,119	**1**	**0,476**	-0,010	**-0,572**	**0,462**
income per m	**0,284**	**0,337**	0,225	0,166	**0,476**	**1**	**0,286**	-0,267	0,261
number of chi	**0,646**	**0,666**	0,073	**-0,420**	-0,010	**0,286**	**1**	0,040	-0,158
skills	-0,094	0,086	**-0,445**	0,095	**-0,572**	-0,267	0,040	**1**	-0,008
density	0,025	0,029	**0,278**	0,146	**0,462**	0,261	-0,158	-0,008	**1**

Les valeurs en gras sont significativement différentes de 0 à un niveau de signification alpha=0,05

Table A29: Pearson correlation matrix

	F1	F2
Valeur propre	2,979	2,253
Variabilité (%)	33,103	25,030
% cumulé	33,103	58,133

Table A30: Eigen values

Observation	F1	F2
1	-0,393	1,026
3	0,710	0,284
4	-0,353	1,242
5	0,941	0,345
6	3,626	-2,916
72	-1,090	1,482
73	0,718	2,113
81	-1,484	-1,381
82	-3,504	-1,971
a	-0,917	1,130
b	-1,473	0,733
c	0,738	-0,568
d	-0,238	0,476
e	-0,377	0,278
f	0,541	-0,161
g	-0,214	-0,050
h	1,196	1,189
i	-0,019	-0,053
j	1,548	0,371
k	-0,332	1,268
l	0,385	1,103
m	-0,260	1,419
n	0,381	1,869
o	-0,026	1,627
p	2,056	-0,176
q	1,104	1,313
r	1,035	0,627
s	1,147	0,364
t	0,905	-0,230
u	2,712	-3,275
v	3,301	-2,049
w	3,746	-2,476
x	3,305	-2,459
y	2,830	-0,553
z	-1,164	1,182
aa	-2,309	0,220
bb	-1,326	0,889
cc	-0,480	1,973
dd	-1,593	1,306
ee	1,190	1,397
ff	0,976	1,952
gg	-0,388	2,068
hh	1,377	1,815
ii	0,267	1,553
jj	-1,000	-1,431
kk	-1,167	-1,601
ll	-0,710	-1,007
mm	-0,903	-0,602
nn	-0,571	-1,165
oo	-2,986	-1,965
pp	-3,164	-2,172
qq	-2,714	-2,093
rr	-2,971	-2,447
ss	-2,606	-1,813

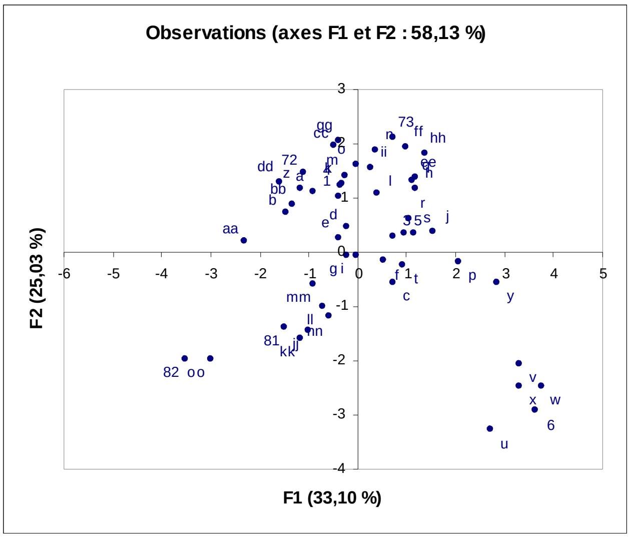

Table A31: Observation coordinates

Appendix 12: Distributions comparison (Barangay Bugo)

Test de Wilcoxon signé / Test bilatéral :

V	12421189,000
Espérance	6463035,000
Variance (V)	10953767152,375
p-value (bilaté	< 0,0001
alpha	0,05

La p-value exacte n'a pas pu être calculée. Une approximation a été utilisée pour calculer la p-value.

Interprétation du test :
H0 : La distribution des deux échantillons n'est pas significativement différente.
Ha : Les distributions des deux échantillons sont significativement différentes.
Etant donné que la p-value calculée est inférieure au niveau de signification alpha=0,05, on doit rejeter l'hypothèse nulle H0, et retenir l'hypothèse alternative Ha.
Le risque de rejeter l'hypothèse nulle H0 alors qu'elle est vraie est inférieur à 0,01%.

Des ex-aequo ont été détectés et les corrections appropriées ont été appliquées.

Figure A4 : Wilcoxon test

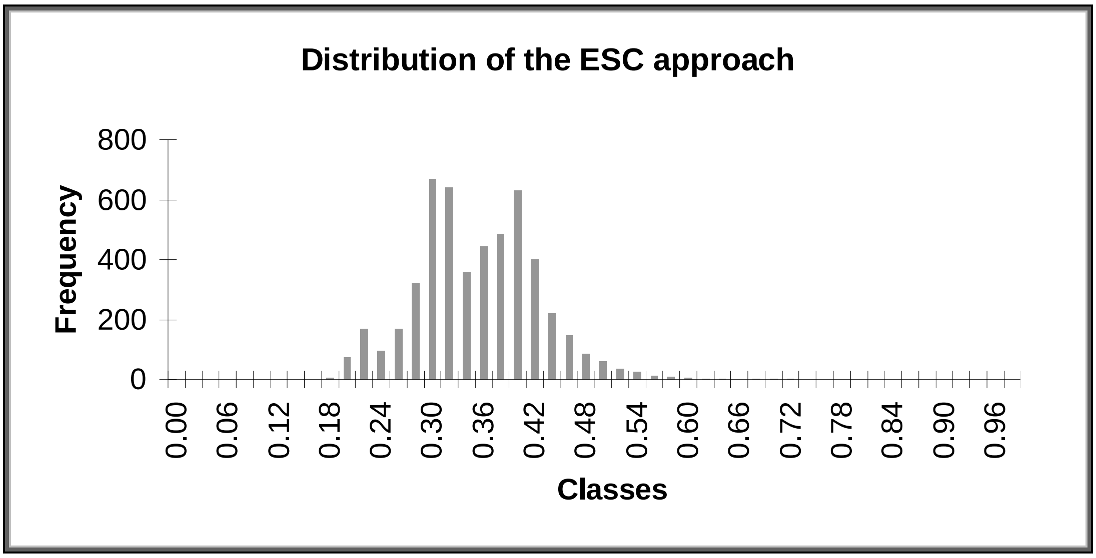

Figure A5: Distribution of the ESC approach (Barangay Bugo)

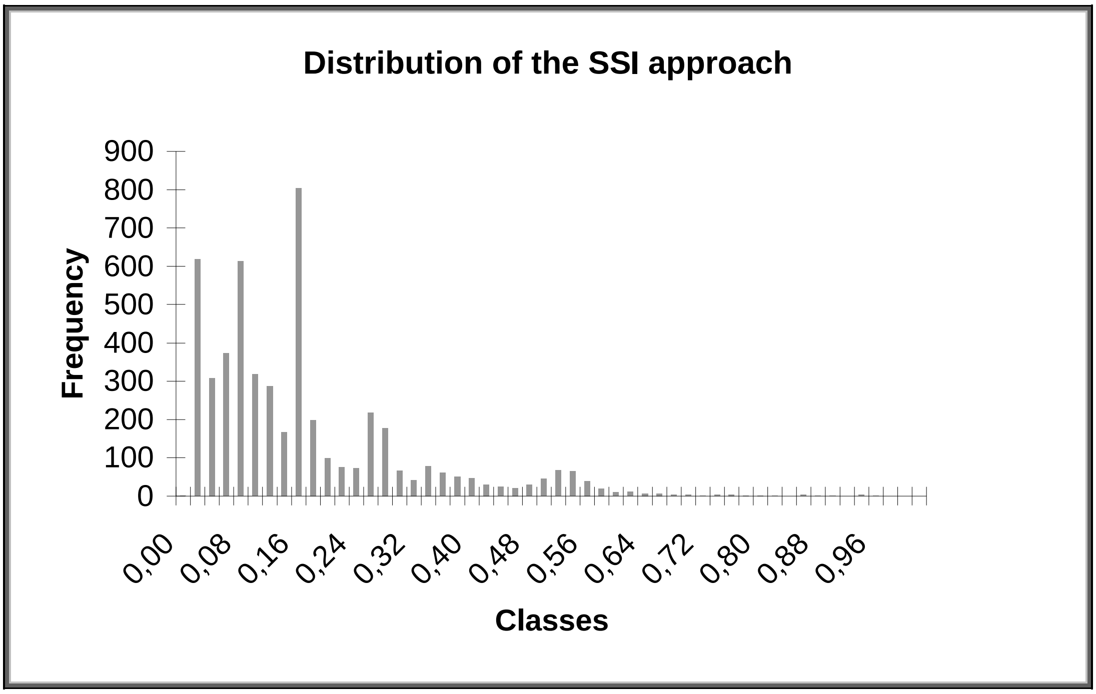

Figure A6: Distribution of the SSI approach (Barangay Bugo)

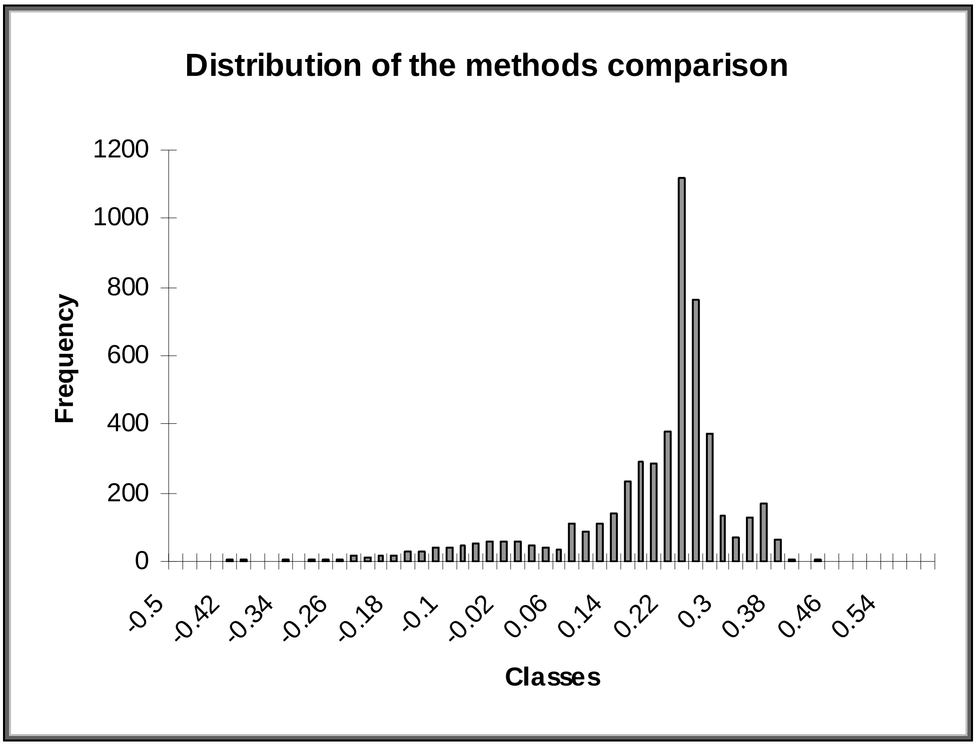

Figure A7: Distribution of the methods comparison (Barangay Bugo)

References

ABETO R., CALILUNG Z., TALUBO J., CUMATANG B., 2004- *Community Mapping in the Philippines: A Case Study on the Ancestral Domain Claim of the Higa-onons in Impasug-ong, Bukidnon.* Philippine Association for Intercultural Development (PAFID) and Agtulawon-Mintapod Higaonon Cumadon; Paper presented at the Regional Community Mapping Network Workshop; 8-10 November 2004, Quezon City, Philippines.

ADNAN S., BARREN A., NURUL ALAM S., BRUSTINOW A., 1992- *People's participation: NGOs and the flood action plan.* Dhaka, Bangladesh: Research and Advisory Services.

AHMED S., ALI M., 2004 -Partnerships for solid waste management in developing countries: linking theories to realities. *Habitat International,* 28: 467-479.

ALLISON M., HARRIS P., 1996- *A Review of the Use of Urban Waste in Peri-Urban Interface Production Systems.* Henry Doubleday Research Association, Coventry. In: MIDMORE D., JANSEN H., 2003. Supplying vegetables to Asian cities: is there a case for peri-urban production? *Food Policy,* 28: 13–27.

AQUINO E., BATAC J., 2003 –Investment in UA to reduce urban poverty in the Philippines- *UA magazine*, 9: 34-36.

ARMSTRONG P., 1993- Perspectives on the development of group decision support systems for location problem-solving. *Geographical Systems*, 1(1), 69-8. In: MACEACHREN A., 2000, Cartography and GIS: facilitating collaboration. *Progress in Human Geography*, 24(3): 445-456.

ARNSTEIN S., 1969- A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4): 216-24.

ATKINSON S., 1995- Approaches and Actors in Urban Food Security in Developing Countries. *Habitat International*, 19(2), 151-163.

BACOLOD CITY, GIS CITY PLANNING, DEVELOPMENT OFFICE, 2005 -*Integrated community-based information system*. Bacolod City, Philippines: CPDO, 75p.

BACOLOD CITY, CPDO, RESEARCH AND STATISTICS DIVISION, 2002- *Bacolod trends, 2002*. Bacolod City, Philippines: CPDO, 95p.

BACOLOD CITY, CPDO, CITY DEVELOPMENT COUNCIL, 2000 –*Comprehensive Land Use Plan (2001-2010).* Bacolod City, Philippines: CPDO, 234p.

BACOLOD CITY, CPDO, 1998, -*Socio-Economic profiles of Purok Magnolia*. Bacolod City Barangay council, 3p.

BATTY, M., LONGLEY P., 1994- Fractal Cities: A Geometry of Forms and Function. New York: Academic Press.

BAUER T., STEINNOCHER K. (2001): Per plot land use classification in urban areas applying a rule-based technique. *GeoBIT/GIS,* 6: 24-27.

BEAUCHEMIN C., 2002- Surmonter le doute statistique: le cas de l'émigration urbaine en Côte d'Ivoire. *Espace, populations, sociétés*, 1-2: 165-177.

BEGUIN H., 1979- Méthodes d'analyse géographique quantitative**.** Paris, Litec, 252p.

BEINAT E., NIJKAMP P., 1998- *Multicriteria Analysis for land-use management*. The Netherlands: Kluwer Academic, 368p.

CARVER S., 1991- Integrating multi-criteria evaluation with Geographical Information Systems. *International Journal of Geographical Information Systems*. 5(3): 321-339.

CARVER S., 2001- *Participation and Geographical Information: a position paper* Position paper for the ESF-NSF Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information, Spoleto, 6-8 December 2001.

CASEY L., PEDERSON T., 2002- Mapping Philadelphia's neighbourhoods. In: CRAIG W., HARRIS T., D. WEINER, 2002- *Community participation and Geographic Information Systems.* London: Taylor and Francis, 383p.

CHAPMAN D., 2003- The Home and Social Status: International Library of Sociology I: Class, Race and Social Structure. Routledge, 320p.

CIA, 2005- https://www.cia.gov/library/publications/the-world-factbook/geos/rp.html

COHEN B., 2004- Urban Growth in Developing Countries: A Review of Current Trends and a Caution Regarding Existing Forecasts. *World Development*, 32(1): 23–51.

COLMAN D, YOUNG T., 1989 -Principles of agricultural economics markets and prices in less developed countries. Cambridge: University Press, 323p.

COX T., 2005 – *An introduction to multivariate data analysis*. London: Hodder Arnold, 232p.

CRAIG W., HARRIS T., D. WEINER, 2002- *Community participation and Geographic Information Systems.* London: Taylor and Francis, 383p.

CRUZ M.C., MEDINA R.S., 2003- *Agriculture in the City: a Key to Sustainability in Havana, Cuba.* Kingston: Ian Randle Publishers, 244p.

DI GESSA S., 2008- Participatory Mapping as a tool for empowerment. Experiences and lessons learned from the ILC network. The ILC 'Knowledge for Change' Series.

DOLAN R., 1991 - *Philippines: A Country Study.* Washington: GPO for the Library of Congress, 297p.

DONNAY J-P, 2005- *Remote sensing and urban analysis*. Londres: Taylor and Francis, 268p.

DRESCHER A. (c), 2001- The integration of UA into urban planning – An analysis of the current status and constraints in ETC-RUAF, 2001. Annotated bibliography on UA. Netherlands: CTA, 804p.

DRESCHER A, HOLMER R., 2007- Beyond project borderlines- the Asia Urbs project, GIS based urban environmental planning and food security project. *APT-reports*, 16: 99p.

EASTMAN J., JIN W., KYEM P., TOLEDANO J., 1993a- A procedure for multi-objective decision making in GIS under conditions of competing objectives. Proceedings EGIS'93: 438-447.

EASTMAN J., JIN W., KYEM P., TOLEDANO J., 1993 b- *GIS and decision making*, vol. 4, Explorations in Geographic Information system Technology, UNITAR, Geneva.

EASTMAN J., JIN W., KYEM P., TOLEDANO J., 1995- Raster procedures for multi-criteria/Multi-Objective decisions. *Photogrammetric Engineering & Remote sensing*, 61(5): 539-547.

EASTMAN J., 1997- *IDRISI for Windows: User's guide. Version 2.0.* Clark University, Graduate school of geography, Worcester, MA.

EICHER C., STAATZ M., 1985- *Agricultural development in the third world.* Baltimore: The Johns Hopkins University Press (2nd edition): 615p.

ELWOOD S., 2002- The impacts of GIS use for neighbourhood revitalization in Minneapolis. In: CRAIG W., HARRIS T., D. WEINER, 2002- *Community participation and Geographic Information Systems.* London: Taylor and Francis, 383p.

ESSC, CBFMO, DENR, 1998- Community mapping manual for resource management. Manila: ESSC: 45p.

EVERITT B., DUNN G., 1991-*Applied Multivariate Data Analysis*. London: Arnold, 303p.

FAO: http://www.fao.org/ag/magazine/9901sp2.htm

FIDA, 2000- Deux études de cas sur la collaboration entre le FIDA, les organisations non-gouvernementales et le gouvernement d'Arménie. Division Proche-Orient et Afrique du nord, Département de gestion des projets 35p.

FORRESTER J., CAMBRIDGE H., CINDERBY S., 1999- The value and role of GIS to planned urban management and development in cities in developing countries1999. Stockholm Environment Institute - York, University of York, UK.

FOX J., RINDFUSS R., WALSH S., MISHRA V., 2004- People and the environment: approaches for linking household and community surveys to remote sensing and GIS. Dordrecht: Kluwer academic publishers, 344p.

FULGINITI L., PERRIN R., 1998- Agricultural productivity in developing countries. *Agricultural economics* 19: 45-51.

GARDNER B., RAUSSER G., 2001- *Handbook of agricultural economics*. Volume 1. North-Holland: Elsevier, 836p.

GELDERMANN J., BERTSCH V, TREITZ M., FRENCH S., PAPAMICHAIL K., HÄMÄLÄINEN R., 2006- Multi-criteria decision support and evaluation of strategies for nuclear remediation management. *Omega* 37: 238 – 251.

GENEAU DE LAMARLIERE I., STASZAK J-F., 2000- Principes de géographie économique. France : Bréal, 448p.

GHOSE R., ELWOOD S., 2003- "Public Participation GIS and Local Political Context: Propositions and Research Directions." *USIRA Journal* 15, APA II: 17-24.

GONZALEZ R., 2002- Joint learning with GIS: multi-actor resource management. *Agricultural Systems*, 73: 99–111.

GOODCHILD M., 1995- *GIS and Geographical Research*. In: PICKLES J., 1995- *Ground Truth.* New York, Guilford Press: 31-50.

GRAILLOT D., WAAUB J-P., 2006- Aide à la décision pour l'aménagement du territoire : méthodes et outils. Paris: Lavoisier, 437p.

GUANZON Y., HOLMER R., nd- Perceptions of households on solid waste management in Bugo, Cagayan de Oro City. Cagayan de Oro: Puvep, ?.

HARRIS T., WEINER D., WARNER T., LEVIN R., 1995- Pursuing social goals through participatory GIS: redressing South Africa's historical political ecology. In: PICKLES

J., 1995.-*Ground Truth: The social implications of geographic information systems.* New York: Guilford Press, 196-222.

HARRIS T., WEINER D., 1998- Empowerment, marginalization, and "community-integrated" GIS. *Cartography and Geographic Information Systems*, 25(2): 67-76. In: MACEACHREN A., 2000- Cartography and GIS: facilitating collaboration. *Progress in Human Geography*, 24(3): 445-456.

HEADY E., DILLON J., 1966- *Agricultural production functions*. Iowa: state university press: 667p.

HEALEY P., 1996- The communicative turn in planning theory and its implications for spatial strategy formation. *Environment and Planning B: Planning and Design,* 23(2): 217–34.

HEROLD M, GOLDSTEIN N.C., CLARKE K., 2003- The spatio temporal form of urban growth: measurement, analysis and modelling. *Remote sensing of environment*, 86(3): 286-302.

HEROLD M., COUCLELIS H., CLARKE K., 2005- The role of spatial metrics in the analysis and modelling of urban land use change. *Computers, environment and urban systems*, 29: 369-399.

HOFMANN P., STROBL J., BLASCHKE T., KUX H., 2006- *Detecting informal settlements from Quickbird data in Rio de Janeiro using an object based approach*. Proceedings of the 1st International Conference on Object-based Image Analysis (OBIA), Austria.

HOFMANN P., 2001- Detecting Informal Settlements from IKONOS Image Data Using Methods of Object Oriented Image Analysis – An Example from Cape Town (South Africa). Germany: Jürgens, C. (Ed.): Remote Sensing of Urban Areas / Fernerkundung in urbanen Räumen. Regensburg: University Regensburg, pp. 41-42.

HOLMER R., ANSELMO M., SCHNITZLER W., 2001 (b)- *Integration of peri-urban food production into solid waste management programs: a case study from the Philippines*. Prepared for the conference "Rural-Urban Encounters: Managing the Environment of the Peri-Urban Interface", Development Planning Unit, University College London.

HOLMER R., ANSELMO M., SCHNITZLER W., 2001- Appropriate methods for micro enterprise development in agriculture. *UA magazine*, 5(topic 6):51-53.

HOLMER R., CLAVEJO M., DONGUS S. , DRESCHER A., 2003 : Allotment Gardens for Philippine Cities. *Urban Agriculture Magazine*, 11: 29-31.

HUTCHINSON C., TOLEDANO J., 1993- Guidelines for demonstrating GIS based on participatory development. *International journal of Geographical Information systems*, 7(5): 453-461.

JANKOWSKI, P., EWART G., 1996- Spatial decision support system for health practitioners: Selecting a location for rural health practice, *International Journal of Geographical Information Systems*, 3(2), 279-299.

JANKOWSKI P., NYERGES T., SMITH A., MOORE T., HORVATH E., 1997- Spatial group choice: a SDSS tool for collaborative spatial decision-making. *International Journal of Geographical Information Systems*, 11(6): 566- 602.

JONES B., 1990- *Neighbourhood Planning: A Guide for Citizens and Planners,* Chicago and Washington, D.C.: Planners Press, American Planning Association. In: CRAIG W., HARRIS T., D. WEINER, 2002- *Community participation and Geographic Information Systems.* London: Taylor and Francis, 383p.

KAUFMANN, D., AART K., ZOIDO-LOBAT P., 2007- Aggregating Governance Indicators. *World Bank Policy Research*, Working Paper No. 2195.

KEEN P., SCOTT-MORTON M., 1978- *Decision support systems: an organizational perspective*. Reading, MA: Addison-Weslay. In: MALCZEWSKI J., 1999. *GIS and multicriteria decision analysis*. New York: John Wiley & sons, 392p.

KIENBERGER S., STEINBRUCH F., 2005- P-GIS and disaster risk management: Assessing vulnerability with P-GIS methods – Experiences from Búzi, Mozambique. Paper presented to the International Conference on Participatory Spatial Information Management and Communication, PGIS 05, Nairobi, Kenya.

KNOX P., 1994- Urbanization. Englewood Cliffs, N.J.: Prentice-Hall.

KYEM A., 2005- Q&A: GIT&S and PGIS for developing countries. *ICT Update*, 27: 8.

KRISHNA B., 2002- *Community GIS or Community vs. GIS*? GIS@development.

LAI S., HOPKINS D., 1995- Can decision-makers express multiattribute preferences using AHP and MUT? An experiment. *Environment and planning B*, 22(1): 21-34.

LARANCE L., 1998- Building Social Capital from the Center: A Village-Level Investigation of Bangladesh's Grameen Bank. *Grameen Trust Working Paper,* September 1998.

LASIMBANG A., 2004- Community Mapping in Malaysia The use of Community Maps in Resources Management and Protecting Rights over Indigenous Peoples' Territory. Paper presented at the Regional Community Mapping Network Workshop November 8 – 10, 2004, Diliman, Quezon City, Philippines.

LEITNER H., MCMASTER R., ELWOOD S., MCMASTER S., SHEPPARD E., 2002- Models for making GIS available to community organizations: dimensions of difference and appropriateness. In: CRAIG W., HARRIS T., D. WEINER, 2002- *Community participation and Geographic Information Systems.* London: Taylor and Francis, 383p.

LONGLEY P., BATTY M., 1996- *Spatial Analysis Modelling in a GIS Environment.* New York*:* John Wiley and Sons, 392p.

LY A, 2001- Outils participatifs d'identification des priorités et d'analyse des discours et des pratiques dans le domaine de l'agriculture urbaine. *UA magazine*, background paper, number 5, workshop on appropriate methodologies for UA research, Nairobi.

MAANTAI J., ZIEGLER J., 2006- *GIS for the urban environment*. USA: ESRI press: 596p.

MACGARIGAL, K., MARKS B. 1994- Fragstats: spatial pattern analysis program for quantifying landscape structure (version 2,0)

MALCZEWSKI J., 1999. *GIS and multicriteria decision analysis*. New York: John Wiley & sons, 392p.

MACEACHREN A., 2000- Cartography and GIS: facilitating collaboration. *Progress in Human Geography*, 24(3): 445-456.

MATHER C., 1997- Geographic Information Systems, mapping and development practice. *Science, technology and Development,* 15(2-3), 291-302. In: CARVER S., 2001- *Participation and Geographical Information: a position paper* Position paper for the ESF-NSF Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information, Spoleto, 6-8 December 2001.

MCCALL M., 2003- Seeking good governance in participatory-GIS:a review of processes and governance dimensions in applying GIS to participatory spatial planning. *Habitat International,* 27: 549–573.

MCMILLEN D., 1996- Multiple regime bid-rent function estimation. *Journal of urban economics*,41: 301-319.

MIDMORE D., 1995- Social, economic and environmental constraints and opportunities in peri-urban and vegetable production systems and related technological interventions. In: Vegetable Production in the Tropics and Subtropics in Peri-Urban Areas_Food, Income and Quality of Life. DSW/ZEL and ATSAF, November 14–17, 1994, Zschortau, Germany, pp. 64–87.

MIDMORE D., JANSEN H., 2003- Supplying vegetables to Asian cities: is there a case for peri-urban production? *Food Policy,* 28: 13–27.

MILLER R., SMALL C., 2003- Cities From Space: Potential Applications of Remote Sensing in Urban Environmental Research and Policy. *Environmental Science & Policy*, 6(2): 129-137.

NAUDET J.-D., 1999- *Bien savoir ce que l'on ignore. Réflexion sur la fragilité de l'information statistique en Afrique*. Document de travail présenté au colloque : 'Enquêtes et systèmes d'information', IRD/ENSEA/Afristrat.

NELSON G., 2002- Introduction to the special issue on spatial analysis for agricultural economists. *Agricultural Economics* 27(3): 197-200.

OBERMEYER N., 1998- "The Evolution of Public Participation GIS", *Cartography and Geographic Information Systems,* 25(2): 65-66.

OPENSHAW S., 1997- The truth about Ground Truth. *Transactions in GIS*, 2(1), 7-24.

ORBAN F., VILLANUEVA C., 2001- Can geography contribute to sustainable and socio-equitable development?. *Revue des questions scientifiques*, 172 (2): 129-146.

PHILIPPINE WORKING GROUP ON COMMUNITY FOREST MANAGEMENT, 1999- *Forest People Facing Change: Learning of the Philippine Working Group on Community Forest Management, volume 2*. Quezon City: Environmental Science for Social Change, 79p.

PICKLES J., 1995- Ground Truth: The social implications of geographic information systems. Guilford Press: New York, 248p.

PIETERSEN K, 2006- Multiple criteria decision analysis (MCDA): A tool to support sustainable management of groundwater resources in South Africa**.** *Water SA,* 32 (2): 119-128.

PNUD, 2005- Le temps des ambitions hardies, Rapport annuel du PNUD. New-York: PNUD , 44p.

PRETTY J., 1994- Alternative systems of inquiry for sustainable agriculture. *IDS Bulletin,* 25(2), 37-48.

PUISSANT A., SHEEREN D., WEBER C., GANÇARSKI P., WEMMERT C., 2006- Amélioration des connaissances sur l'environnement urbain : intérêt de l'intégration de règles et de l'utilisation de classifications multi-formalisme. Actes du colloque « Interactions Nature-Société : analyses et modèles », La Baule (France), 5p.

PUVeP, 2008: *Philippine allotment garden manual with an introduction to ecological sanitation.* Periurban Vegetable Project (PUVeP), Xavier University College of Agriculture, Cagayan de Oro City, Philippines. 104 p

QUISUMBING A. MCNIVEN S., 2005- Migration and the Rural-Urban Continuum: Evidence from the Rural Philippines. *Discussion Paper BRIEFS, Food Consumption and Nutrition Division of the International Food Policy Research Institute*, Discussion Paper 197.

RAMASUBRAMANIAN L., 1995- Building communities: GIS and participatory decision making. *The journal of urban technology*, 3(1): 67-79.

RAMBALDI G., CALLOSA-TARR J., 2004- *Participatory 3-D Modelling: Bridging the Gap between Communities and GIS Technology*. In: Neef, Participatory approaches for sustainable land use in Southeast Asia. White Lotus Co. Ltd., Bangkok.

ROEGIERS J., 2002- Impact de la réforme agraire aux Philippines: Etude de cas dans la province de Negros Occidental. Mémoire, FUNDP, Département des sciences économiques, p ?.

ROSENTHAL R., 1985- Concepts, theory and techniques: principals of multiobjective optimization. *Decision Sciences*, 16(2): 135-152.

RUAF, CD-ROM, November 2003- UA video, RUAF, Resource Centre on UA and forestry.

SAMUELSON P., 1983- Thünen at two hundred. *Journal of economic literature* 21: 1468-1488.

SANDERS L., 2001- *Modèles en analyse spatiale*. Paris: Lavoisier, 333p.

SHAFIUL A., MANSOOR A., 2004- Partnerships for solid waste management in developing countries: linking theories to realities. *Habitat International*, 28(3): 467-479.

SHARMA S., 2007- People vs. poverty: Powering through partnership. *Futures,* 39 (5): 625–631.

SMYTH E., 2001- Would the Internet widen public participation? Unpublished MRes Thesis, University of Leeds.

SORIAGA R., WALPOLE P, 2006- Forest for poverty reduction: opportunities in Asia-Pacific Region. Pre-Session Workshop, India.

STEWART E., JACOBSON D., DRAPER D., 2008- Public participation geographic information systems (PPGIS): challenges of implementation in Churchill, Manitoba. *The Canadian Geographer / Le Géographe canadien,* 52(3): 351–366.

SUMBERG J., 0KALI C., 1989- Farmers, On-Farm Research and New Technology. In: HUTCHINSON C., TOLEDANO J., 1993- Guidelines for demonstrating GIS based on participatory development. *International journal of Geographical Information systems*, 7(5): 453-461.

THAPA R., MURAYAMA Y., 2008- Land evaluation for peri-UA using analytical hierarchical process and geographic information system techniques: A case study of Hanoi. *Land Use Policy*, 25(2): 225-239.

THOMSON C., HARDIN P., 2000- Remote sensing/GIS integration to identify potential low-income housing sites. *Cities*, 17(2): 97-109.

THOMAS N., HENDRIX C., CONGALTON R., 2003- A comparison of urban mapping methods using high-resolution digital imagery. *Photogrammetric Engineering and Remote Sensing,* 69(9): 963-972.

TIWARI S., KUMAR A., KUMAR A., 2005- Development & standardization of a scale to measure socio-economic status in urban & rural communities in India. Indian Journal of Medical Research, 122, 309-314.

UNCHS (Habitat), 2001- *Facts and figures about conditions in human settlements in* UN-HABITAT's, 2001 - State of the World's Cities: 2001. UN: New York, 121p.

UNITED NATIONS, 2001- Reducing disparities; balances development of rural areas and regions within the countries. New-York: UN, 140p.

UNHSP, 2002- *City-to-City Cooperation: Issues Arising from Experience*, draft work in progress, Second Interim Report prepared as an input to discussions at the First Session of the World Urban Forum, Nairobi.

VEREGIN H., 1995- Computer innovation and adoption in geography: A critique of conventional technological models. In : PICKLES J, 2005- Ground Truth. Guilford Press, New York: 88-112.

VINCKE P., 1989- *L'aide multicritère à la décision.* Bruxelles: Editions de l'Université de Bruxelles.

VOOGD H., 1983- Multicriteria Evaluation for Urban and Regional Planning. Pion, Ltd., London. In: EASTMAN J., JIN W., KYEM P., TOLEDANO J., 1995- Raster procedures for multi-crteria/Multi-Objective decisions. *Photogrammetric Engineering & Remote sensing*, 61(5): 539-547.

VOSS A., DENISOVICH I., GATALSKY P., GAVOUCHIDIS K., KLOTZ A., ROEDER S., VOSS H., 2004- Evolution of a participatory GIS. *Computers, Environment and Urban Systems,* 28: 635–651.

WATES N., 2000- *The community mapping handbook*. London: Earthscan, 230p.

WATSON D., PHILIP G., 1985- A Refinement of Inverse Distance Weighted Interpolation. *Geo-Processing*, 2: 315-327.

WESCOTT G., 2002- Partnerships for capacity building: community, governments and universities working together. *Ocean and Coastal Management,* 45: 549-571.

WORLD BANK, 2000. 'Philippines, Growth with Equity: The Remaining Agenda.' World Bank Report No. 20066-PH. Washington, DC.

WORLD BANK, 1997- *Philippines: Managing Global Integration*. Vol. II, World Bank Report No. 17024-PH, Washington, DC.

WORLD BANK, 2002- *Philippines development policy review: An opportunity for renewed poverty reduction*. Washington, DC (USA): World Bank, East Asia and Pacific Regional Office, 62p.

List of Figures

List of tables

List of appendixes