Urbanization strategies and agrarian change in Eastern China: a multilevel integrated assessment of domestic land grabbing

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Urbanization strategies and agrarian change in Eastern China: a multilevel integrated assessment of domestic land grabbing

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Abstract:
This paper explores the links between urbanization strategies and domestic land grabbing processes in a rural village located in Chongming island. Chongming is currently the poorest district of Shanghai. One of the most significant development interventions in the island is the rural-urban migration policy. That is, the displacement of rural people from rural villages to cities. This intervention is part of the official rural development strategy of China, which emphasizes that an effective reduction of the urban-rural income gap should be based on the transformation from rural to urban and from traditional to industrial agriculture. This paper investigates the implication and trade-offs of such policies for the local population and for sustainable local development, in terms of: land-use changes, food self-sufficiency, livelihoods of small-scale farmers, economic development, as well as environmental protection. Besides contributing to the analysis of the impacts of urbanization strategies on local communities and agro-ecosystems, this paper gives an empirical contribution to the discussion of the influence of development strategies on the agrarian change and the domestic land grabbing process in China.

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1. Introduction

The urbanization process of rural populations represents an increasing phenomenon all over the world. According to World Bank projections, the level of people living in cities is constantly increasing. Moreover, it has been estimated that almost all of the world's population growth between 2000 and 2030 will be concentrated in urban areas in developing countries (United Nations, 2005). Among developing countries, China shows one of the highest rates of urbanization. In the last few years, rural population has decreased by 13%, ranging from 73% of the total population in the 90's to 60% in 2005. According to the latest United Nations population projections, by 2030 almost 60% of the total population will live in urban areas (figure 1).

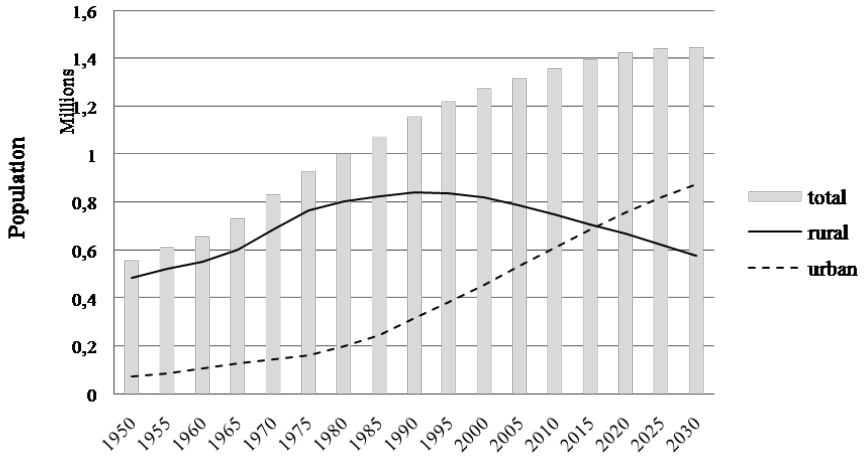

Figure 1 Changes in Chinese rural-urban population from 1950 to 2030. **Source:** United Nations data and projections (United Nations, 2005)

Rural-urban migration is used to describe the population movements from the countryside to towns and cities that usually accompany economic expansion. Migrants typically move to urban areas in search of economic opportunities. This phenomenon is particularly significant in transition countries (TCs), such as China, emerging from a planned economy towards a market-based economy, where rural poverty and the rural-urban income gap are usually a side effect of the rapid economic development (van Westen, 2011). In China, "increasing economic liberalism, integration into the global market and the policies designed to support these economic goals have favored fast economic growth, especially in the coastal regions, and these have become the dominant trends" (McGranaham and Tacoli, 2006).

One of the consequences of the integration of the Chinese economy into the world market is the transition from an agrarian society to one based increasingly on industrial production, while urbanization and livelihood changes of the population proceed rapidly (Christiansen, 2009).

The major threat of development under rapid urbanization and economic growth in China is increasing socio-economic inequalities especially between rural and urban areas. On average, the per capita disposable income of urban residents is more than three times the per capita disposable income of rural residents. Overall income inequality is now higher than it was before the 1949 revolution (van Westen, 2011). This aspect has been indicated in the literature as the proximate driver of the rural-urban migrations in the country, and therefore the major factor contributing to urbanization (McGranahan and Tacoli, 2006).

In China, urbanization is seen by policy-makers and planners as a formal strategy to thinning the rural-urban gap[1]. According to the 11th and 12th Five-Year Plans, specific interventions to improve the standard of living in rural areas are expected to focus explicitly on increasing rural urbanization, agricultural modernization and intensification (11th Five-Year Plan, 2006-2010; 12th Five-Year Plan, 2011-2015). In most cases, the rural urbanization process is accompanied by land dispossession and forced migrations of the population from rural areas to new cities or towns (McGranaham and Tacoli, 2006). The achievement of modernization and higher productivity of the agricultural sector requires the introduction of better farming techniques (mechanization and irrigation) as well as larger plot sizes than those prevailing in rural areas of China[2] (van Westen, 2011). Hence, the major stated reasons for the Chinese state to launch rural urbanization processes are two: (i) to reduce the growing rural-urban income gap; and (ii) to boost the agricultural productivity combining fragmented plots into ones suitable for mechanization.

The agrarian change, which is expected to occur under the above mentioned strategy, is the process of commodification of the land. The latter reflects the transition from a rural society characterized by a large number of small farmers and subsistence agriculture to one increasingly based on the expansion of capital-intensive production enterprises to feed the rising urban population (Perkins, 2006). This phenomenon can be also seen as a type of domestic land grabbing, in which local governments together with investment holdings and agro-industrial firms are promoting (on behalf of rural development) the dispossession of farmland and rural-urban migrations. Although, there is evidence that domestic investors are also playing a major role in land acquisitions for biofuel production in Africa (Cotula et al., 2009; Zoomers, 2010; Kugelman et al., 2010), little is known so far about domestic land grabbing induced by development and linked to urbanization in particular. This issue requires more attention through sound monitoring and analyses.

The urbanization strategy of China described above and the consequent land grabbing process, can help mitigate some of the income inequalities resulting from the uneven economic growth between rural and urban areas, but can also affect the current state of the rural environment and the socio-economic condition of the population.

The magnitude and the rapidity characterizing the urbanization process in China, has aroused the attention of the scientific community. At present, a growing number of studies have examined the impacts of urbanization processes on social and ecological systems. These studies are mainly focused on the social and environmental consequences of rapid urbanization in urban areas, or on the estimation of the impact of urban sprawl on soil resources (see as an example Ren, 2003; Tan et al., 2005; Xiao, 2006; Chen, 2007; Deng et al., 2009; Liu et al., 2010). Furthermore, various papers have analyzed the role played by China as a land grabber in foreign countries, especially in Africa (Cotula et al., 2009; World Bank, 2010). However, the potential implications that urbanization policies could have on rural systems from an integrated perspective, and taking into account domestic land grabbing, has been largely neglected. This paper looks at the implications of rural-urban migration policies and the domestic land grabbing, for land use changes, economic efficiency and the environment. Drawing on an example from a rural area in east China, where forced migrations of the population from sparsely-located rural villages to concentrated cities have been

[1] An urbanization strategy can be defined as a set of policies designed to influence the spatial distribution of the population and its economic activities (McGranahan and Tacoli, 2006). It refers to urban and rural policies, such as the reclassification of settlements from rural to urban, redrawing of the boundaries of urban centers, rural-urban migration and land use change, etc. This paper analyzes the rural-urban migration strategy and the rural land use change in particular, with a focus toward the impacts of this policy strategy on migrants' home areas.

[2] In China the average farm size is estimated between 0.4 and 1.2 hectares.

planned for the year 2020, it discusses the likely consequences of this model of development for rural communities and agro-ecosystems comprising economic, environmental and social aspects. The paper analyzes this type of development model by asking the following research questions: What are the socio-economic and environmental consequences of urbanization strategies and domestic land grabbing in the area of study? In which ways do the land use and the metabolism of rural systems change? What are the impacts on the function and structure of those systems?

To answer to the above questions an integrated framework for sustainability impact assessment is applied to compare different typologies of households (off-farm, on-farm and partially off-farm), and scenarios of land use, resulting from the urbanization interventions. In particular, the land use scenarios compared are: (1) the "business as usual (BAU)" scenario, which is the current situation represented by a Chinese rural village; (2) the "intensive agriculture" scenario, resulting from the urbanization strategy, which aims at shifting the land use of the village into only agricultural land and intensive methods, as well as at displacing the local population from the rural village to the city; and (3) the "input reduction program" scenario, which is the same as the previous one in terms of land-use, but with the introduction of a fertilizer and pesticide reduction program. The scenarios reflect the main policy strategies in the area of study, as indicated in Chinese documents. The unit of investigation of the analysis is the village, as a logical consequence of the fact that the interventions are directed toward the concentration of the population from sparsely-located rural villages into new medium-sized concentrated cities.

The framework is built upon the combination of multi-criteria (Munda, 2005 and 2008) with societal metabolism analysis (Giampietro, 2003; Giampietro and Mayumi 2000a and 2000b).

In particular, links between the theoretical developments in the fields of societal metabolism and multi-criteria approaches are established, and practical applications in land-use policy evaluation are suggested. The societal metabolism can be considered has a method which analyzes the interactions between society and its material environment measuring their matter and energy exchanges. According to this approach each socioeconomic system has a metabolic profile determined by the quantity and characteristics of their material and energy inputs and outputs (Fischer-Kowalski, 1998). The application of the metabolic concepts to the analysis of rural systems, land grabbing and the agrarian change has received an increasing attention from a diverse range of disciplines. Social scientists have entered in the discussion focusing on the farming practices as a whole set of ecological and social relations, as well as a way to specify how humans interact with non-human nature and to what effects (Schneider et al., 2010). In this paper metabolic profiles of different land uses are analyzed and compared in terms of energy flow, human time and monetary flow. Moreover, multidimensional indicators are selected to represent the local policy targets in a multi-criteria setting for trade-off assessments of land-use scenarios and household typologies. The methodological framework is multi-level (household and village levels), integrated (economic, environmental and social aspects are taken into consideration) and involves stakeholders for data gathering and to obtain general information on the local context. The focus of this paper is on the relationship between rural-urban migration and the agrarian change, with particular attention to the challenges posed by the development of the migrants' home areas. The structure of the analysis has been based on the realization of three main phases: (i) problem and scenario definition; (ii) assessing the effectiveness of the policy intervention in a multi-criteria setting; (iii) evaluating the impacts and analyzing the trade-offs of the policy on rural systems. The rest of the paper is organized as follows: section 2 briefly introduces the main aspects that characterize China's modern

rural development policy. Sections 3 and 4 present the study area, methods and data sources. Section 5 presents the results obtained at the household and village (scenarios) levels. Finally, section 6 discusses those results and draws some conclusions from a rural development policy perspective.

2. Problem definition

2.1 China's modern rural development strategy and the rural-urban gap

The rural development strategies of China were formulated, for the first time, in 2001 with the 10th Five-Year Plan. The Plan identified the achievement of a "*xiaokang*" (all around better off) society as a national goal. This concept is not only related to the economic development of rural areas but also comprises the environmental and social sustainability, and the application of modern science and technology to raise productivity and generate greater benefits. The key strategies of the 10th Five-Year Plan are as follows (China's 10th Five-Year Plan, 2006-2010):

- Emphasizing human resource development;
- Reducing social disparities, especially rural-urban and regional gaps;
- Improving the management of the rural-urban transition;
- Protecting the environment and natural resources.

With regards to cities and rural area disparities in particular, the Government emphasizes that an effective reduction in the urban-rural income gap should be based on the transformation from *rural to urban* and *from traditional agriculture to industrial agriculture or industry and services*. After China's 10th Five-Year Plan focusing on development strategies to be achieved between 2001 and 2005, a new Plan has been designed for the period 2006-2010 (11th FYP). This is what was officially declared in the China's 11th FYP for National Economic and Social Development: "With the implementation of the 11th FYP, urban and rural development will be more balanced. Noticeable progress will be made in building a socialist new countryside and the urbanization rate will be raised"; furthermore, "the 11th FYP period gives top priority to the issues of "agriculture, rural areas and farmers" among all strategic tasks, adheres to the balanced rural and urban development promoting urbanization" (China's 11th FYP). The recently published first draft of China's 12th FYP (2011-2015), follows this same direction and its guidelines will be approved by the National People's Congress (NPC) in March 2011. It promotes the creation of new towns in rural areas and furthermore, it states that "with the deepening of industrialization and urbanization, coordinated efforts should be made to push forward rural modernization" (China's 12th FYP, 2011-2015).
Thus, China as a developing country is facing, in addition to the environmental protection of rural areas, increasing rural-urban gaps in income, poverty and living standards. With this in mind, Figure 2 shows the income gap between rural and urban households from 1990 to 2006 in Shanghai (comprising all 18 county-level divisions: Shanghai proper, inner suburbs, outer suburbs and the islands). As one can see, the gap is constantly increasing and the growth rate of urban households' incomes is almost twice that of rural households (8.5 versus 4.5, respectively).

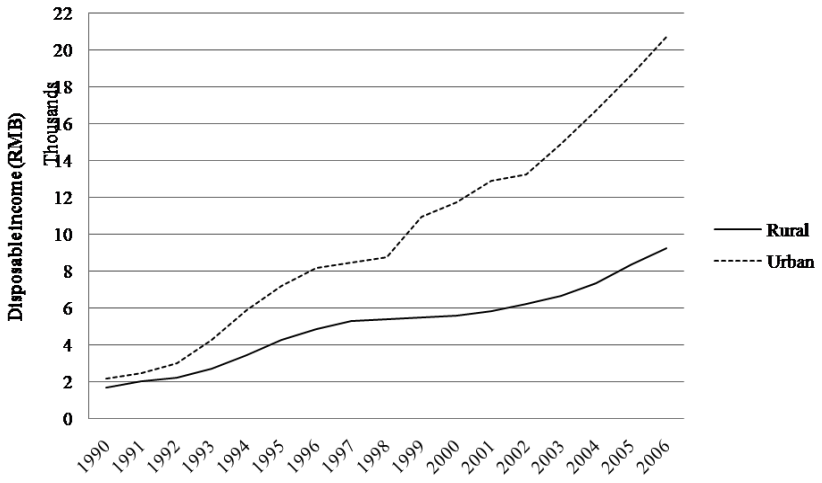

Figure 2 Disposable incomes of rural and urban households in Shanghai from 1990 to 2006. **Source:** Shanghai Statistical Bureau (Statistical Yearbook, 2007)

Due to this situation, the reduction of the rural-urban income inequalities in China represents a priority objective of the rural development strategies. This fact explains why at present, urbanization is taken into account by Chinese policy-makers as a way to achieve rural development[3]. This process of urbanization of populations (i.e. rural communities becoming part of the urban environment) is closely linked to a process of domestic land grabbing and commodification of land (Perkins, 2006). Under the migration policy and the intensification of the agricultural sector (12th FYP), what is likely to happen in rural areas is the expansion of capital-intensive agricultural enterprises, whose production will have the purpose of feeding the rising urban concentration. Land use change and land use intensity have the potential to reduce the rural-urban gap but also to affect the current state of the rural environment and the socio-economic conditions of the rural population. In the following sections, the implications of this process of urbanization and commodification of rural land are analyzed for the village of Hongxing in eastern China. In Hongxing farmers' dispossession of land and their displacement toward the city, together with the extension of intensive agricultural productions managed by agro-industrial firms, have been planned for the year 2020. In particular, the study area is located in the east coast of China in a peri-urbanising region close to the main industrial city of Shanghai. It is a dynamic area, which is experiencing one of the fastest processes of economic growth and migration trends in the whole of China.

3. Case study description

3.1 Context

Hongxing village is located in the eastern part of Chongming island (figure 3). Chongming, with an area of 1,411 km^2 and a total population of 697,101 inhabitants (Statistical Yearbook, 2007), is the

[3] Urbanization strategies are not new in China. China's City Planning Law adopted in 1989 stated that the national strategy for urbanization has to be based on the following measures: (i) strictly control the development of large cities; (ii) rationally develop medium-sized cities; and (iii) vigorously promote the development of small cities and towns (Ma, 2004). However, these measures were not meant by Chinese planners as a rural development strategy or directed explicitly toward rural areas as is the case of the policy interventions analyzed here.

third largest island in China and is administrated by Shanghai's Municipal Government. It is currently the poorest district of Shanghai in terms of social and economic development. The economic structure is dominated by the agricultural sector which led the economy of the island with more than 50% of the total gross income produced in 2007 (Statistical Yearbook, 2007). In the agricultural sector plantation, livestock and aquaculture activities contribute to the production of the main fraction of the gross agricultural output value.

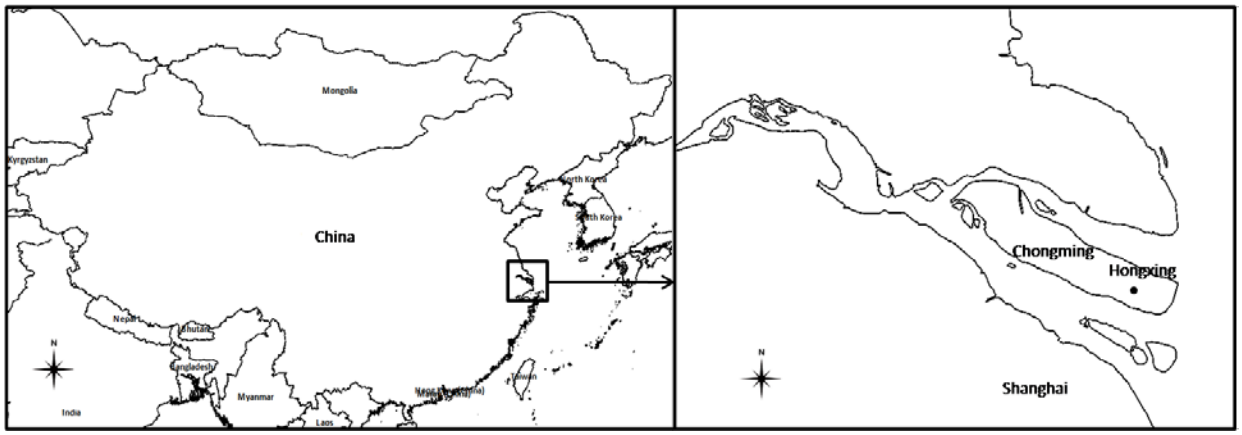

Figure 3 Chongming island and approximate location of Hongxing village

The industrial sector is based mainly on the production of universal equipment, metal products, traffic and transportation vehicles, and construction. However, the total population living solely on industry is very low, underlining the traditional agricultural profile of the island. According to the official statistics (Statistical Yearbook, 2007), the urban population reaches just 28% of the total population and is concentrated over 16 towns. The island is considered as the last "pristine land" in eastern China. However, the high population density has put great pressure on the natural and economic resources, in particular through the use of a massive amount of fertilizers in agricultural production. This excessive use of inputs in the agricultural sector is in fact one of the main sources of pollution in Chongming island. A study realized by the Centre of Competence for the Innovation in the agro-environmental sector (Agroinnova) of the University of Turin, in collaboration with the Shanghai Academy of Environmental Sciences (SAES), reveals the use of approximately 300 kg/ha of fertilizers (far over the national safety limit of 225 kg/ha) for conventional cultivations in Chongming. One of the consequences of the excessive use of fertilizers is the process of salinization of the soil which also represents the main source of environmental degradation on the island (Gullino et al, 2006; Sino-Italian Cooperation Project, 2008). The major ecosystem types on the island are agro-ecosystems and natural wetland ecosystems. The vegetation has been greatly modified by human activity. As a consequence, the native forest covers just a small area of the entire island and approximately 16.8% of the land is covered by manmade forest. As a result, agro-ecosystems dominate most of the land use and provide most of the food supply for the city of Shanghai (Huang et al., 2008). Hongxing village presents the same general characteristics of Chongming. Hongxing has a population of 2,683 inhabitants (on average 2.5 people per household, as a consequence of the birth planning program, i.e. one child per couple birth limitation policy promoted in 1979 by the central government). The majority of the economically active population is engaged in agricultural activities for both subsistence and commercial purposes. The agricultural sector is still dominated by traditional cultivation techniques with the use of manual work instead of

tractors. Main cultivations are: fruit, vegetables, corn, paddy and wheat. Among these, vegetables and in particular cauliflowers, prevail in terms of number of hectares. Vegetables, fruit and corn represent the most productive cultivations in terms of income generation; wheat and paddy are primarily subsistence crops. In particular, based on information collected on the field during an interview with the head of the village and questionnaires to farmers, 98% of paddy is cultivated for subsistence, wheat 52%, vegetables 19%, corn 10%, fruit 3%. Livestock activity is also carried out mainly for subsistence; only a small number of households raise animals for commercial purposes. From a demographic point of view, the population in Hongxing is, for the most part, made up of the elderly, aged 65 and over.

3.2 Definition of the scenarios

One of the main projects undertaken recently by Shanghai's Municipal Government is the development of a master plan of Chongming island. The master plan refers to the guidelines of the 11th FYP for Chongming National Economic and Social Development approved in the 4th Session of the 13th National People's Congress of China (NPC) (The Master Plan of Development of Chongming, 2005-2020) (State Council of China, 2004). The main intervention of the plan is the gradual integration of the sparsely-located rural villages of Chongming into new denser cities located along the cost. Therefore, the urban development of the island will be confined to eight new, and highly-compact coastal cities at a high enough density to enable a population of approximately 600,000 people to live and work in just 15 percent of the island's total area (SOM, 2006). The above mentioned intervention requires a massive expropriation of the village land owned by local farmers and communities, in exchange for a compensation for the affected village population. Moreover, the intervention foresees the diffusion in the expropriated land of intensive agricultural productions managed by investment holdings and agro-industrial firms [4]. Land dispossessions and resettlements are not new in China. Various studies have analyzed the impacts of involuntary resettlements of people forced to move from their lands due to the realization of development projects, such as the construction of hydropower plants or other infrastructure investments (Zhao et al., 2011). However, land dispossession for agricultural productivity purposes and the reduction of the rural-urban income gap, which are analyzed here, have received little attention. Although resettlement programs and land dispossession are usually accompanied by a compensation package for the affected population (van Westen, 2011), such as monetary compensations, apartment relocation, new jobs and resettlement subsides, according to past experiences in China many people who have lost their farmlands could not restore their livelihoods after relocation (Yuefang et al., 2003). Moreover, involuntary resettlement and land dispossessions are commonly associated with the impoverishment of local communities, the destruction of their productive assets and social cohesion (Cernea, 2000). In this context, the analysis of the potential implications that the domestic land grabbing linked to urbanization strategies could have on the rural population and rural ecosystems is of paramount importance. Since the intervention of the Chongming master plan described above, is directed mainly toward rural villages, the analysis of the effectiveness of the Chinese urbanization policy has been realized taking the village as the main

[4] The presence of investment holdings managing large tracts of land for agricultural purposes has already taking place on the island. The main presence in terms of hectares cultivated is the SIIC Dongtan Investment & Development (Holdings) Co., Ltd, which is a conglomerate fully-funded by the Shanghai Municipality. SIIC together with agro-industrial firms manages the eastern part of the island with an agricultural area called Dongtan Modern Agricultural Area, where intensive agricultural production is performed.

unit of investigation. Hongxing village was selected as the case study area[5] with the help of Chinese research institutions and experts, based on: (1) previous participation of the village in agricultural projects in collaboration with research institutions of Shanghai, such as the Shanghai Academy of Environmental Sciences (SAES); (2) its proximity to the coast. To assess the impacts of the rural development pathway described above, the current situation of Hongxing village was compared with what the village is expected to become after the implementation of the urbanization policy. In particular, the scenarios reflect the land use change, from traditional to intensive methods, the migration of the population that will occur in the area with respect to the current situation together with the introduction of a input reduction program, which has been already tested by a pilot project realized in an area closed to the village (Gullino et al, 2006; Sino-Italian Cooperation Project, 2008). The input reduction program responds to the needs of the agricultural sector to take measures against the salinization of the land, which is posing serious threats to the fertility and productivity of the soil (Sino-Italian Cooperation Project, 2008). The scenarios compared therefore, are listed:

1) "Business-as-usual scenario" (i.e. Hongxing village). This scenario supposes that the current land use management does not change over time. The test area is characterized by different land uses, such as human settlements and the agro-ecosystem, and by the realization of traditional agriculture;
2) "Intensive agriculture". This scenario supposes that the land use shifts to only agricultural land. The test area is then characterized by one land use, the agro-ecosystem, and by the realization of intensive agriculture.
3) "Input reduction program". This scenario has the main characteristics of the previous one in terms of land use, i.e. only agricultural land, but differs with regards to the introduction of a fertilizer and pesticide reduction program.

Besides reviewing the policy and institutional context, in this preliminary phase of the analysis the stakeholders (agricultural technicians and the head of the village), were approached to provide expert knowledge on the agricultural sector of Hongxing. The information collected was used to identify the main characteristics of each of the scenarios and for the classification of the agricultural methods in two different categories: low external power agriculture (LEPA)[6], which is the current method adopted in the area; and high external power agriculture (HEPA), which is the method that will be introduced by the policy intervention. In short, the two scenarios relate to different patterns of land use (multi-functional versus mono-functional land uses, see Fig. 4), as well as to different agricultural paradigms (traditional versus mechanized agricultural methods). Traditional agriculture is performed without the use of machines, referred to from here on as LEPA. On the contrary, the mechanized agriculture paradigm is based on the extensive use of tractors, referred to from here on as HEPA. The former is realized prevalently for subsistence purposes, it is based on manual work instead of using machines. The latter is strongly market oriented, tends to be capital-intensive and highly mechanized. For what concerns the migration aspect, the entire area will be uninhabited under scenarios 2 and 3; human presence will be restricted to hired workers in the agricultural

[5] Since the majority of the rural villages in the east part of the island present the same characteristics in terms of dimensions, population, life style and activities performed, Hongxing can be considered as representative of all of them.

[6] This classification differs from the High External Input Agriculture (HEIA) and Low External Input Agriculture (LEIA) definitions which are generally used in literature to make a distinction between organic and conventional agriculture and the use of fertilizers and pesticides (Pimentel et al., 1989). The High External Power Agriculture (HEPA) and Low External Power Agriculture (LEPA) definitions put the attention on the mechanization of the agricultural sector. These definitions seemed to be more appropriate to differentiate the traditional from the intensive agriculture scenario in this case study since in China the traditional system also foresees the use of a consistent amount of fertilizers and pesticides.

sector. The next figure visualizes the land use change that will occur in Hongxing village according to the master plan of Chongming and table 1 gives an overview of the main characteristics of each scenario.

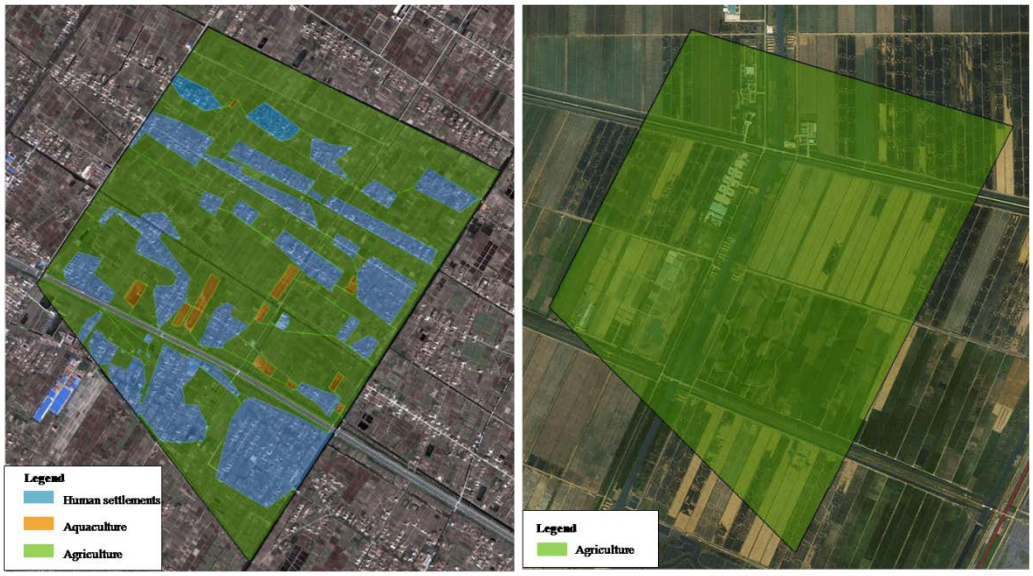

Figure 4 Representation of the scenarios according to different land uses

Table 1 Overview of the alternative land-use scenarios

Scenarios	Main characteristics
BAU scenario **Hongxing village**	• **Multi-functional land use**: human settlements (local communities), aquaculture, and agriculture (agro-ecosystems) • **LEPA - Low External Power Agriculture**: low capital-intensive, weakly market oriented (mostly subsistence agriculture), not mechanized • **Conventional agricultural methods**: no reduction of inputs in terms of fertilizers and pesticides • **Reproducing human system**: system characterized by the presence of a variety of work patterns (on-farm, off-farm and partially off-farm household typologies)
Scenario 2 **Intensive agriculture**	• **Mono-functional land use**: agriculture (only agro-ecosystem) • **HEPA – High External Power Agriculture**: strongly market oriented, capital-intensive, highly mechanized. • **Conventional agricultural methods**: no reduction of inputs in terms of fertilizers and pesticides • **Non-reproducing human system**: system characterized by the presence of only agrarian seasonal work (mainly hired workers in retirement)
Scenario 3 **Input reduction program**	• **Mono-functional land use**: agriculture (only agro-ecosystem) • **HEPA – High External Power Agriculture**: strongly market oriented, capital-intensive, highly mechanized • **Inputs reduction program**: reduction of inputs in terms of fertilizers and the use of organic pesticides **Non-reproducing human system**: system characterized by the presence of only agrarian seasonal work (mainly hired workers in retirement)

4. Methodological framework

The framework of the analysis builds upon two complementary approaches, the societal metabolism and the multi-criteria methods, adapted to the context under investigation and for the purposes of the analysis.

The concept of societal or industrial metabolism is based on the notion that economic systems can be analyzed in terms of material and energy transformations with metabolic pathways that evolve over time (Ayres and Simonis, 1994; Fischer-Kowalski, 1998; Fischer-Kowalski and Haberl, 2007). Societal metabolism has been applied to the analysis of sustainability, investigating the links between social activities and resource use and has been established as a key concept in sustainability science (Kuskova et al., 2008). This way of analyzing social systems fully reflects the concept of Bioeconomics suggested by Georgescu-Roegen (Georgescu-Roegen, 1971, 1975; Mayumi and Gowdy, 1999), in addition to the pioneering work done in the energy analysis of economic systems by various researchers (Leach, 1976; Pimentel and Pimentel, 1979; Martinez Alier and Schlupmann, 1987). According to these studies, analysing the metabolism of human systems means integrating the economic flows with matter and energy flows within scientific analyzes (Giampietro and Mayumi, 2000a, 2000b). This approach is particularly useful to investigate whether or not a human system is following a sustainable path over time or in comparison with other systems (see for example Falconi, 2001; Grünbühel and Shandl, 2005; Kuskova et al., 2008; Ramos-Martin et al., 2009).

The societal metabolism approach used in this case study refers to the Multiple-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) and its application to the analysis of rural systems (Pastore et al., 1999; Gomiero, 2001). According to the MuSIASEM approach both economic and energy flows are analyzed with respect to the human time and land use variables (Giampietro and Mayumi, 2000b). The approach is based on the assumption that land and time become the most crucial resources in agrarian societies, especially in developing countries. The idea underlying this method is that any social-ecological system can be represented by time and land variables allocated between various working and non-working activities, and land use patterns, which in turn are associated with different economic and energy performances (Pastore et al., 1999).

Table 2 Variables used to analyze the metabolism of alternative land-use scenarios

Variables	Unit	Description
Intensive variables		
Labor productivity	RMB/hour/year	Monetary flow generated per hour of work
Energy use	MJ/ha/year	Energy flow per unit of land
Human activity per unit of land	hour/ha/year	Hours of human activities per unit of land
Extensive variables		
Total human activity	hours/year	Total hours of human activity in a year composed of: working hours, physiological overhead, leisure and education
Working time	hours/year	Total working hours: hours dedicated to income generating activities
Non-working time	hours/year	Total non-working hours: hours dedicated to physiological overhead, leisure and education
Total consumption of energy	MJ/year	Total energy consumed in a year expressed in mega joule
Total monetary flow	RMB/year	Total monetary flow generated in a year

According to this approach, different land-uses are compared in this paper based on their size, expressed in hours of human activity, total consumption of energy and total monetary flow generated (defined as extensive variables), and at the same time according to their economic and environmental performances (defined as intensive variables) (table 2).

In the application of this approach to the metabolism of Hongxing village, it is possible to analyze the land use change determined by the switch to the HEPA system– on the right of Fig. 4 – compared with the traditional one - on the left of Fig. 4, with respect to "what the system is", in terms of: (1) the human activities performed in the area, expressed by the variables "working time" (time dedicated to income generating activities, i.e. off-farm and on-farm activities) and "non-working time" (time dedicated to leisure and education and physiological overhead); (2) the economic flow generated by the working population (i.e. the gross income generated in a year); (3) the energy flows generated by the working and non-working activities performed "in situ" (in this case study agricultural activities). At the same time, this information is combined to obtain multidimensional indicators, which explain "what the system does" in metabolic terms, in this case: labour productivity, energy use and human activity per unit of land.

This preliminary information was used to describe the different metabolism of the scenarios in an integrated perspective. However, with the intention of discussing the effectiveness of the rural urbanization policy to achieve the local development targets, the information obtained employing the MuSIASEM approach was translated into a set of proper evaluation criteria which is able to represent each policy goal and perform a trade-off analysis using a multi-criteria approach. In this sense, the results of the MuSIASEM application were also considered has an input of the multi-criteria analysis.

With regard to policy evaluation, employing a multi-criteria approach is essential to capture the multidimensional aspects of the policy objectives. This approach is therefore, able to take into consideration specific evaluation criteria, by the realization of quantitative and qualitative assessments using factors in the environmental, social and economic dimensions (Janssen and Munda, 2001; Munda, 2008). Various examples of empirical studies have applied these methods in the field of public policy evaluation and environmental management (see as an example Gamboa, 2006; Stagl, 2006; Munda, 2006; Gamboa and Munda, 2007; Russi, 2008; Siciliano, 2009). The indicators selected for the Hongxing village case study and the rational followed for the selection is illustrated in the following section 4.1.

The framework is multi-level (household and village levels) and integrated (economic, environmental and social aspects are taken into consideration). An important step of the analysis is the gathering of data and information, needed for both the estimation of the variables and to understand the regional and local contexts. Part of the framework is therefore based on the involvement of local people and key actors through questionnaires and interviews (see section 4.2 on data gathering). These actors are rural households, the head of the village, experts from academics and agricultural associations operating in the area of study, all of whom will be affected by the urbanization decision and action or have a knowledge of the main characteristics and problems of the area. Finally, the method used to perform the multi-level analysis, at the household and village levels, was based upon a bottom-up aggregation procedure and the use of typologies of households (see section 4.2). The household typologies were compared in order to analyze the effectiveness of the urbanization policy in achieving development goals at the household level according to socio-economic criteria as indicated in table 3.

4.1 Indicator selection

Table 3 illustrates the indicators selected for the multi-criteria analysis of the land use scenarios and refer (the indicators) to the local economic, environmental and social policy goals. The indicators are quantitative or qualitative and in some cases they differ according to the level of the analysis they refer to, i.e. household or village. Some indicators, such as the food-self sufficiency or net income, were not evaluated at the village level due to their specificity to the household level. Likewise, the environmental indicators where only applied at the village level for the same reasons. The indicators have been selected based on: (i) information collected on the field; (ii) the analysis of Chinese policy documents; and (iii) in collaboration with academic experts, agricultural associations operating in the area of study, in addition to the head of the village using formal and informal interviews. The local people were not involved in the indicator selection phase through a specific participatory process. Interaction with local people was mainly related to consultation on inputs and outputs of the analysis. Therefore, the indicators selected do not represent the needs and expectations of the local population, instead they reflect the rural development goals based on the policy review.

Table 3 Description of the indicators selected at the household and village levels

Dimensions and criteria	Unit	Description	Related policy goals	Scale of the policy[a]	Level of analysis
Economic dimension					
1) Labor Productivity	RMB[b]/hour	Gross income generated per hour of work (comprising also the "virtual income")	Economic development	National	Household and village
2) Net income	RMB/year	Gross income generated by the household minus life expenditures	Increasing the income per capita/reducing rural-urban income gap	Local	Household
Social dimension					
3) Food self-sufficiency	%	Percentage of food self-sufficiency or independence from market for food consumption	Food security	National	Household
4) Diversification of risk	Qualitative	Qualitative evaluation based on the fractions (%) of the income generated by on-farm and off-farm activities	Diversification of the rural economy	Local and Regional	Household and village
5) Working time	hour ha-1 year-1	Time dedicated by the local population to working activities	Reduction of the rural population	Local and Regional	Village
6) Non-working time	hour ha-1 year-1	Time dedicated by the local population to non-working activities			
Environmental dimension					
7) Use of pesticides	Kg $ha^{-1}year^{-1}$	Amount of chemical pesticides utilized in agriculture per unit of land in a year	Good management of natural resources, environmental protection, reducing pollution on soil	All scales	Village
8) Nitrogen use	Kg $ha^{-1}year^{-1}$	Amount of nitrogen utilized in agriculture per unit of land in a year			Village
9) Energy use	MJ/ha/year	Energy flow per unit of land			Village

[a] National refers to China, regional to Shanghai and local to Chongming; [b]RMB-Renminbi (people's money) is the Chinese currency.
Source: The Master Plan of Development of Chongming, 2005-2020, 11th Five-Year Plan of Shanghai Municipality, 11th Five-Year Plan for National Economy and Social Development of China

The environmental policy objective in the area of study refers to a reduction in the use of pesticides and fertilizers. The highly-polluted conventional agriculture is in fact the main source of environmental degradation on Chongming island (see section 3.1 for a clarification of this statement). This target refers to the indicators for the use of nitrogen and pesticides. The main socio-economic targets aim at: (i) improving the productivity of the agricultural sector; (ii) enhancing the diversification of the rural economy; and (iii) thinning the rural-urban income gap. These targets refer to the labor productivity, diversification of risk and net income indicators. The two indicators "working time" and "non-working time" are considered exemplificative of the pre and post urbanization policy context with regard to: (i) the presence of the population in the area of study; (ii) the change of the land use function; as well as (iii) the policy goal which refers to the reduction of the rural population in the area (i.e. migration strategy). For example, the presence of the "working time" alone indicates that the area is used for the production of the agricultural output only, as a consequence the rural communities are no longer living in the area (i.e. the commodification of the land). The food self-sufficiency[7] indicator refers to the policy target which aims to ensure food security. This indicator has been evaluated at the household level to take into account the impact that the urbanization strategy could have on the households' food self-sufficiency, as well as on their dependence to the market for food provision.
Finally, the energy use indicator refers to the most general objective of "good management of natural resources" with reference to the fossil energy consumption of the scenarios per unit of land. China is one of the members of the 3 Country (China, Brazil and India) Energy Efficiency Project. As a part of this project, the Chinese government's efforts are focused on enforcing the gradual restriction on the use of fossil fuels[8]. The primary objective of this policy measure is to protect the environment and to prevent the occurrence of adverse changes in climate. As one can see from table 3 all the environmental indicators refer to the land use change occurring at the village level. This aspect is explained by the fact that the analysis is restricted to an area delimitated by the borders of the village. Therefore, the environmental impact which refers to the activities performed by households outside of the village is not taken into account[9]. What the paper attempts to analyze at the household level is how the urbanization has the potential to affect the livelihood of the population in relation to socio-economic targets (i.e. reducing the rural-urban income gap, enhancing food security, supporting the diversification of risk, and increasing economic productivity) more than their environmental loading.

4.2 Data gathering

The analysis is based upon a household survey conducted between October 2008 and January 2009 in Hongxing village on 104 households (representing approximately 10% of the total number of households in the village). Household information includes farm and non-farm activities, income by source, energy consumption, human time and land use (see appendix A for a detailed description of the variables and their quantification). This data was complemented with information on the

[7] The concept of food self-sufficiency is generally taken to mean the extent to which a country, a region, an individual, a village, a household can satisfy its food needs from its own domestic production (FAO, 1999a).
[8] More information on the Three Country Energy Efficiency Project can be found at: http://www.3countryee.org/
[9] For example, under scenarios 2 and 3 the pollution relative to off-farm household activities performed in the city, is not relevant in this case since they are not localized within the area of study. On the contrary, the gross income generated by off-farm households performing their working activities outside but living in the village is accounted at both village and household levels. This is considered as an economic flow entering the system under investigation. The same rationale applies for the human time variables.

agricultural characteristics of Hongxing village and Chongming island, from agricultural technicians, the head of the village and experts from Chinese research institutions, such as the Shanghai Academy of Environmental Sciences (SAES) and UNEP-Tongji Institute of Environment for Sustainable Development. The same variables were also employed for the creation of the household typologies (i.e. off-farm, on-farm and partially off-farm) by means of a clustering procedure based on a multi-variate statistical analysis[10] (Köbrich et al., 2003; Usai et al., 2006). Data used for the evaluation of scenario 2 was collected in the field by asking the agricultural technicians of an area (Dongtan) where intensive agriculture has already been realized (see Table B.1 in Appendix B). This area is located in the vicinity of Hongxing village (approximately 9 km) and has the same morphological and soil characteristics. For what concerns technical information regarding the input reduction program (scenario 3), data from a pilot project realized in Dongtan has been used (Sino-Italian Cooperation project, 2008) (see Table B.2 in Appendix B).
Moreover, the analysis builds upon the application of an aggregation procedure used to scale up data from the household to village level (see Appendix C for the aggregation procedure applied).

5. Results

5.1 Assessing the effectiveness of the policy intervention in a multi-criteria setting

To assess the metabolic patterns of the scenarios the MuSIASEM approach was applied and the variables, described in section 4 and table 2, were evaluated.
This information has been used to obtain characterization of the scenarios in terms of energy consumption, human time, and monetary flows, as indicated in table 4, in relation to different land uses, i.e. traditional versus intensive methods, and urbanization strategies, i.e. the displacement of the local population to the city.

Table 4 Extensive variables: estimation of energy flows, human time and monetary flows for each land-use scenario

Scenarios	Energy flow (MJ /year)	Total Human time (hours/year)	Working time (hours/year)	Non-working time (hours/year)	Monetary flow (t.RMB/year)
BAU scenario – Hongxing village[11]	12,476,000	20,550,233	4,857,030	15,693,203	24,528
Scenario 2 (intensive agriculture)	71,767,789	138,509	138,509	0	6,348
Scenario 3 (input reduction)	68,107,436	152,360	152,360	0	10,156

This information was used as an input to structure the analysis within a multi-criteria setting, in which specific indicators have been selected to represent the policy targets in the area of study. In detail, the analysis of the metabolic pattern of the scenarios has been used to evaluate the indicators energy use[12], labor productivity, and the human time with respect to working and non-working activities. The changes in indicator values associated with the different land-use systems and policy targets were evaluated at both the village and household levels to assess: (i) the impact of the

[10] Detailed information on the multivariate statistical technique used for the clusters construction will be given by the author upon request.
[11] The aggregate data, at the level of the land use system represented by Hongxing village, have been obtained using an aggregation procedure based on the weighted averages according to the distribution of the household typologies over the sample.
12 The evaluation of the energy use has been based on information related to the type, weight and horse power of the tractors, the fertilizer and pesticides used, and the energy consumption related to housing, i.e. personal care, leisure, house working and so on. The conversion factors used to assess the energy equivalents of inputs in the agricultural sector are those indicated in Giampietro, 2002.

migration policy on rural communities and agro-ecosystems; (ii) the effectiveness of the policy intervention to achieve development targets. Results at the household and village levels are presented through the use of an impact matrix and a spider diagram (Reidsma et al., 2010). An impact matrix can be defined as a tool which helps to narrow down a list of items through a systematic approach of comparing objects (Munda, 2008). In this paper, this is done by simultaneously representing the alternative objects under examination (i.e. the scenarios and the different household typologies) and their performances expressed by the scores attached to the previously selected indicators (items). In this way it is possible to structure the results obtained inside a tabular matrix (tables 5 and 6), which contains the following information:

- the indicators used in the analysis (first column);
- the unit of measurement to evaluate the indicators (second column);
- the preferred direction of the criteria, i.e. if the final goal is to maximize or to minimize the indicators (third column)[13];
- the various objects under comparison (fourth, fifth and sixth columns);
- the trade-offs between the dimensions (in this case economic, environmental and social) expressed by the indicators and for each object.

In the spider diagrams (Figures 5 and 6) an increase in the area indicates a positive influence in the achievement of the policy targets[14].

In tables 5 and 6, results are presented for the indicators linked to the household typologies and the land use scenarios.

Table 5 Impact matrix – village level

Indicators	**Unit of measurement**	**Preferred direction**	**BAU scenario Hongxing village**	**Scenario 2 (intensive agriculture)**	**Scenario 3 (input reduction)**
Energy use	MJ/ha/year	Min (↑)	28,947	166,515	155,729
Labor productivity	RMB/hour/year	Max (↑)	5.05	45	67
Non-working time	hour ha^{-1} $year^{-1}$	Min (↓)	46,021	0	0
Diversification of risk	qualitative	Max (↑)	very high	very low	very low
Use of pesticides	kg ha^{-1} $year^{-1}$	Min (↓)	5.4	7.8	0 (only organic pesticides)
Use of nitrogen	kg ha^{-1} $year^{-1}$	Min (↓)	219	291	204

[13] The final goal here refers to the development policy goals listed in table 3.

[14] The spider diagram shows a representation of figures 5 and 6 following a normalization procedure of the indicators' scores displayed in the impact matrices (tables 5 and 6): (x-min)/ (max-min)*100. Where, min and max are the maximum and minimum values, respectively, of the indicator scores and x the starting value to be normalized. Then, to establish the direction of the indicator (maximizing or minimizing) the following equation has been used for the indicators to be minimized with respect to the optimum: -[(x-min)/ (max-min)*100]+100. With the above normalization procedure all of the indicators assume values that go from 0 to 100, where 0 represents the worst situation and 100 the optimum one with respect to the minimum and maximum values assumed by the indicators themselves. This means that a household typology or a scenario that performs better with respect to a criterion, reaching the optimum doesn't represent the optimum in absolute terms but always in relation to the scores obtained by the other typologies or scenarios.

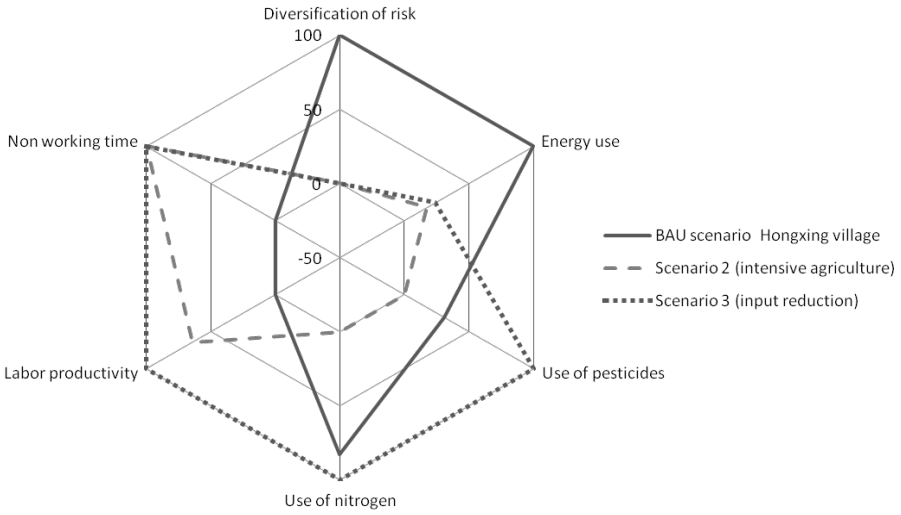

Figure 5 Representation using a spider diagram of the results for the socio-economic and environmental indicators linked to land use scenarios

Table 6 Impact matrix – household level

Indicators	**Unit of measurement**	**Preferred direction**	**Off-farm**	**On-farm**	**Partially off-farm**
Labor productivity	RMB/hour	Max (↑)	6.2	3.4	4.3
Net income	RMB/year	Max (↑)	21,155	5,909	8,827
Diversification of risk	qualitative	Max (↑)	very low	very low	very high
Food self-sufficiency	%	Max (↑)	0	92	89

Source: data collected in Hongxing village in 2008/2009

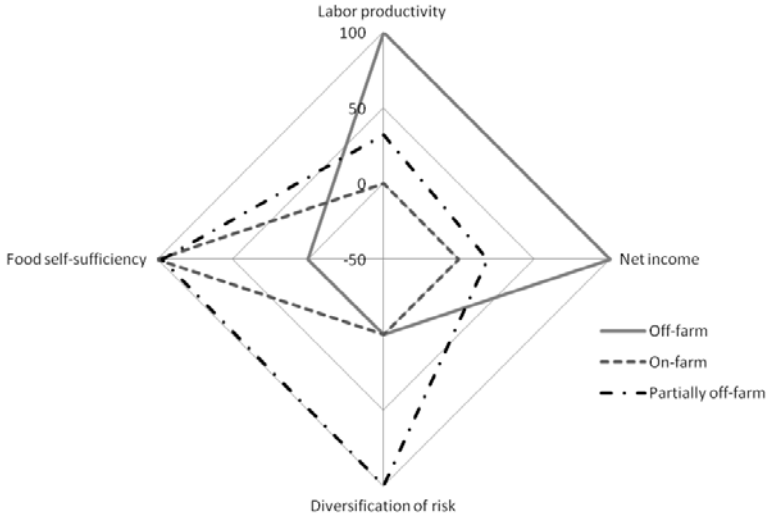

Figure 6 Representation using a spider diagram of the results for the socio-economic indicators linked to household typologies

5.2 Analysing the trade-offs of the urbanization policy at the village and household levels

Comparing indicator values and their trade-offs is part of a multi-criteria analysis (Munda, 2008). This comparison is presented here to assess the effectiveness of the policy intervention to achieve development targets at both of the levels under investigation. To do this, the changes in value of the indicators selected are discussed in the light of their potential to satisfy the policy targets represented by the "preferred direction" (i.e. "max" and "min" in the impact matrix).

At the village level and with regard to the land use change, table 5 and Fig. 5 show that in the current situation (BAU-Hongxing village scenario), the majority of the indicators obtained a better result in comparison with both scenarios 2 and 3. Under scenario 2, only two of the six indicators used for the evaluation have the potential to satisfy the policy targets. These are: labor productivity which increased by approximately 9 times with respect to the current situation value, and the "non-working time" indicator[15]. However, this result is also associated with an increase in the energy use (fossil energy consumption) by approximately 80%, in the use of pesticides by more or less 30% and in the use of nitrogen by 25%. Moreover, according to the "diversification of risk" indicator, the area under scenario 2, presents a very low diversification of the income generated by off-farm and on-farm activities, i.e. only the agriculture activity is performed. The same considerations can be drawn for scenario 3, apart from the environmental dimension. Thanks to the input reduction program, scenario 3 has the potential to reduce the environmental pressure on soil with respect to both the BAU scenario and scenario 2, in addition to reducing the energy use, although this is in comparison only to scenario 2. Simultaneously, under scenario 3 it is possible to obtain a better result in terms of the labor productivity indicator with an increase of 92% with regard to the BAU scenario and 30% with respect to scenario 2.

[15] The urbanization goal relates to the fact that the rural population are no longer living in the area under the land-use intensity scenarios, therefore the human time dedicated to non-working activities equals zero for scenarios 2 and 3. This aspect is relevant to highlight the change of the land use function of the area under the urbanization strategy and its process of commodification which is further explained in section 5.3.

At the household level, the trade-off analysis has been realized comparing the three household typologies - off-farm, on-farm and partially off-farm - where off-farm types are considered representative of the population under scenarios 2 and 3[16]. Table 6 and Figure 6 show that the net income of off-farm household types is higher in comparison with both on-farm and partially off-farm types (respectively, 21,000, 6,000 and 8,800 RMB/year); although this is also associated with a less diversification of risk (with respect to the partially off-farm types only), as well as a higher dependency on market for food (less food-self sufficiency). Thus, an improvement of the income level of the households under the rural urbanization policy (scenarios 2 and 3) may be associated with a problem of food security and economic vulnerability, in terms of the households' income dependence to the off-farm labor market only. This economic vulnerability could be linked to urban poverty which, according to a study conducted by McGranaham and Tacoli (2006), is increasing in China affecting rural residents living nearby industrialized zones and who have lost their land due to migration policies or urbanization trends.

5.3 Human time and land-use function

The change of the human time variable, expressed by the "working time" and "non-working time" (i.e., the time dedicated to leisure, education and physiological overhead) indicators, reveals a switch of the land use function under the urbanization scenarios 2 and 3. In these scenarios, the human time variable is represented by the "working time" dedicated to the agricultural sector only (mainly hired workers of retirement age), which means that the population no longer lives in the area. Therefore, the land use function of these scenarios is the production of food to be sold in markets in cities, mainly to feed the increasing population of the main cities, and in this case, Shanghai.

On the contrary, in the BAU scenario the agricultural production is for the most part used to sustain the food requirement of the local population (subsistence agriculture pattern). In other words, the urbanization scenarios represent a system in which the maximization of the economic efficiency, expressed by the monetary flow per hour of work, is not functional to the reproduction of the local rural communities; instead it focuses on how to optimize the generation of the agricultural outputs for guarantying food security for cities.

According to the results obtained in section 5.2, this process of urbanization and commodification of the rural land has the potential to reduce the rural-urban income inequalities whilst also leading to a smaller diversification of risk and food security of the population which becomes more vulnerable to potential labor and food market crises[17]. Moreover, if the input reduction program is not put in place by specific environmental protection policies, the land use change toward intensive methods will increase the environmental impacts on soil. In fact, in the intensive agriculture scenario, the use of nitrogen is by far over the safety limit established by Chinese institutions: 291 kg/ha versus the 225 kg/ha limit. Finally, with respect to the more general objective of the

[16] Off-farm households are those whose income generation depends upon activities realized completely out of the farm, such as industry or trade and services. On-farm households depend entirely on labor activities performed within the farm, such as cultivation, aquaculture and husbandry. Finally, partial off-farm households represent a combination between the previous two categories, such as indicated in appendix A. Under scenarios 2 and 3 the population will be completely composed of off-farm types due to the implementation of the rural-urban migration policy.

[17] As a result of urbanization, the number of urban poor is predicted to rise and poverty will increasingly be concentrated in the cities and towns (Baker, 2008). It has been also demonstrated by several studies on the links between poverty and urbanization that economic crises and structural adjustment policies have a disproportionate impact on the urban poor, due to rising food prices, declining real wages and a contraction of industrial and public sector employment and reduced public expenditures on basic services and infrastructure (Wratten, 1995).

restriction on the use of fossil fuels, the switch of land use towards intensive methods leads to an increase of the fossil energy consumption per hectare.
As it is important for the government to reduce the rural-urban gap, increase the productivity of the rural areas and in the meantime respect environmental and social targets, a strategy toward a diversification of the rural economy among off-farm and on-farm activities together with the introduction of environmental protection programs may be a feasible alternative to urbanization, as the results obtained by scenario 3 and partially off-farm households may suggest. Indeed, it can be seen in figure 5 that under scenario 3 the introduction of input reduction programs has the potential to reduce the impact on soil whilst at the same time to reach economic targets. Moreover, according to the results illustrated in figure 6, partially off-farm households satisfy the social targets (i.e. diversification of risk and food self sufficiency) and in the meantime have the potential to increase the net income and labor productivity with respect to on-farm types.

6. Discussion and concluding remarks

Recently, the environmental and socio-economic effects of land grabbing processes have received a great deal of attention, and China has been reported as one of the main actor in land deals in various developing countries, such as Africa and South America (World Bank, 2010). However, little is known about a phenomenon of domestic land grabbing induced by development and linked to urbanization strategies in the country. In this context, while there is evidence of the consequences of the land use change due to the expansion of cities, more systematic evaluations are needed to better understand to what extent urbanization policies have the potential to pace the agrarian change of the migrants' home areas and affect the socio-economic condition of the population.
By applying an integrated framework, this paper has analyzed and compared the changes in land use, which are expected to occur due to urbanization strategies in a rural village in east China, to assess: (i) the impact of the migration policy on rural communities and agro-ecosystems and (ii) the effectiveness of the policy intervention to achieve development targets. In particular, links between the theoretical developments in the field of societal metabolism and multi-criteria approaches are established, and practical applications in land-use policy are suggested. Moreover, policies which are currently in place and relevant to the problem have been evaluated.
In the assessment of the rural urbanization policies in Hongxing village various conclusions can be drawn, which refer to: (i) the environmental degradation (soil pollution) and agricultural intensification; (ii) the increasing population in the cities and food security; and finally (iii) the economic efficiency and the multifunctionality of the rural systems.
All these points are connected in a chain of effects driven essentially by the rural-urban gap. More specifically, in order to reduce rural-urban inequalities, development policies promote rural migrations. Migrations increase the urban population and consequently the food demand of cities, which is satisfied by land use change, land dispossessions and agricultural intensification (the adoption of HEPA patterns). This process of domestic land grabbing supported by the government on behalf of rural development, leads to an agrarian change in which the rural areas are not functional for the reproduction of the local rural communities but serve as specialized areas for the production of food to feed the increasing urban population.
According to the results obtained, this process of land grabbing has the potential to boost the agricultural productivity and increase the income level of the rural population. It does, however, lead to higher impacts on soil pollution, higher consumption of fossil fuels, the smaller

diversification of the rural economy together with the specialization of the population in the industrial sector alone, by causing a reduction of food self-sufficiency and an increased vulnerability to potential food and labor market crisis. In spite of this, it can also be seen that with the introduction of specific environmental protection programs (in this case the reduction of fertilizers and pesticides) the impacts on soil could be reduced and at the same time economic targets be fulfilled.

According to the above considerations and results, conclusions on the effectiveness and feasibility of the analyzed policies are drawn with respect to the policy goals stated by the Government. These conclusions illustrate that the forced migration of rural people to cities has the potential to fulfill economic targets (i.e. reduction of rural-urban income gap and efficiency of the agricultural sector), leaving, however, the achievement of social (i.e. food security and diversification of risk) and environmental targets (i.e. soil pollution and fossil fuel consumption) dependent on the introduction of integrative policy measures. In the case study presented here, these integrative measures are not currently taken into account by Chinese policy makers.

Reducing the rural-urban income gap in China is clearly a critical objective for both economic growth and equity. It should not, however, be seen as an alternative to addressing social and environmental targets. Increasing rural incomes and improving rural living conditions does not necessarily have to be obtained through rural-urban migration and farmers' land dispossession. On the contrary, experience in many rural areas of developed and developing countries suggests that rural development policies which have the potential to stimulate the diversification of the rural economy between off-farm and outside farm activities, together with financial support, expert information and education, environmental conservation programs, can all stimulate a rise in the livelihood of rural residents and to maintain farm activities (Niehof et al.,2004; Meert et al., 2006; Demurger et al., 2010).

This study represents a first attempt to gain a deeper understanding of the implications of domestic land grabbing linked to development and urbanization strategies. Domestic land grabbing is likely to play a significant role in the agrarian change process currently underway in China. In this case, the study area is located in the east coast of China in a peri-urbanising region close to the large industrial city of Shanghai. It is a region which is experiencing one of the fastest processes of economic growth and migration trends in the whole of China. Thus, the analysis cannot be considered representative of all rural China, especially with regard to remote rural areas and villages with poor connection to big industrialized cities or regions.

Although the focus is on a small case study, the analysis presented may give useful insights as to how domestic land grabbing induced by development purposes could affect the migrant's home areas from a multi-level and integrated perspective. The methodological framework proposed here has proven valuable in structuring and performing an integrated analysis of land use policies. The indicators used for the integrated representation of the land use scenarios relate to the main local rural development objectives, as indicated in Chinese policy documents. Although the indicators may not represent all the socio-economic and environmental aspects of the problem at hand, they have been useful in order to highlight some important links between urbanization strategies and the agrarian change process in the area of study. The results obtained and the method used can constitute a useful basis for future research in the assessment of the impacts of land grabbing processes and development strategies in rural areas from a multi-level integrated approach.

Appendix A Data collected at the household level in Hongxing village and aggregated in three different classes of households: off-farm, on-farm, and partially off-farm.

Table A Information collected at the household level

Variables	**Off-farm**	**On-farm**	**Partially off-farm**
Number of observations	20	27	38
HH size (average No. of members)	2.95	2.00	2.40
THA - Total Human Activity (hours per year)	25,842	17,520	21,024
Working hours (%)			
Agriculture	-	14.80	12.18
Industry	14.80	-	3.67
Trade & Services	8.14	-	-
Aquaculture	-	-	-
Husbandry	-	2.92	-
Others	-	-	3.58
Households' chores	8.98	8.72	9.63
Non- working hours (%)			
Physiological overhead	45.37	48.80	44.28
Leisure & education	23.00	26.43	25.69
Total income, including virtual income[a] (RMB/year)	37,004	10,914	17,292
On farm (%)			
Agriculture	-	79.94	56.26
Aquaculture	-	-	-
Husbandry	-	8.00	0.30
Off-farm (%)			
Industry	70.21	-	24.60
Trade & Services	29.79	-	-
Others (%)	-	12.08	18.84
Expenditures (RMB/year)	15,849	5,005	8,466
Total Available Land (ha)	0.03	0.43	0.61
Land use (ha)			
House area	0.01	0.01	0.01
Homestead area	0.02	0.01	0.02
Agricultural area	-	0.41	0.58
Energy consumption			
Electricity (kW/month)	45.90	24.35	35.60
Liquefied gas (kg/month)	14.80	20.75	13.77
Fuel (liter/month)	6.55	0.15	0.97
Firewood (kg/month)	-	69.15	8.33

[a] The "virtual income" entry has been evaluated based on the information collected at the household level related to the fraction of the various agricultural products auto-consumed by the household and their average market prices.

Appendix B Information on intensive and input reduction practices

Table B.1 Technical coefficients. Intensive practices

Type of crops	Yield (kg/ha/year)	Pesticides (kg/ha/year)	Nitrogen (kg/ha/year)	Phosphorus (kg/ha/year)	Market price (avg.RMB/kg)	Prod. cost (RMB/ha)	Labor cost (RMB/ha)	Hrs of labor (hr/ha/year)
Fruit	29,999	9	300	127	2.4	8,250	8,250	1,650
Vegetables	14,999	7	300	127	2.5	7,650	6,750	1,350
Wheat	6,000	4	270	82	1.7	6,375	570	142
Paddy	7,875	12	315	82	2.0	7,545	1,425	360
Corn	10,499	6	270	82	1.3	5,790	3,750	930

Source: data from Dongtan Agricultural area, 2008/2009

Table B.2 Technical information regarding eco-friendly practices based on the input reduction program with respect to conventional agriculture

Revenues	Costs of production	Hours of work	Use of pesticides	Use of phosphorus	Use of nitrogen
+60	+20	+10	Only organic pesticides	-40	-30

Source: Agroinnova project (Sino-Italian Cooperation project, 2008)

The Sino-Italian cooperation project aimed to test the possibility of converting the highly-polluted conventional agriculture of Chongming into eco-friendly farming systems, thereby increasing the potential income of local growers. Throughout the project's 3-year implementation, more than 60 Chinese experts, technicians and farmers received training on eco-friendly agriculture based mainly on the reduction of inputs. Experimental field trials were set up to assess the technical and economical feasibility of innovative technologies and some of the results obtained with respect to conventional practices are indicated in table B.2 (for further information on the project see the final report Sino-Italian Cooperation project, 2008).

Appendix C "Scaling-up" procedure to estimate data from rural households to the village level

This appendix presents the formalization of the aggregation procedure used to estimate the variables from the household to the village level. The scaling-up procedure is based upon the weighted average. In particular, the final estimation of the variable at the level of the village (Y_{l+1}) (Eq. C.2) has been obtained by the average of the variables at the household level (Eq. C.1) weighted by the distribution of the household typologies over the sample (n_k/n) and in relation to the total number of households in the village (N) (Eq. C.3).

Eq. (C.1)

Eq. (C.2)

Eq. (C.3)

Where: Y is the variable; K are the typologies of household; A the categories composing the variables (i.e. the gross income is composed for instance by the categories: income from agriculture, industry and other working activities); n is the size of the sample; n_k is the number of observations for typology k; N is the total number of household of the population analyzed; l and l+1 are the household and village levels, respectively.

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