

Land Use, Food Security, and Climate Change in Vietnam

Policy Brief, September 2012



The results of this study are particularly useful to inform policies in Vietnam concerning economic growth, food security, climate change, REDD+, land use, green growth, and climate smart agriculture. The aim of the study on which this Policy Brief is based is to provide better insights about future land use change in Vietnam and how this relates to climate change and food security in Vietnam. The main research questions are: ❶ What is the impact of socio-economic development on land use and land use change for the period 2010-2030 under alternative futures, including climate change? ❷ What is the spatial pattern of land use change in Vietnam? ❸ What are the implications for food security and greenhouse gas emissions?

Results Summary

Socio-economic development, land use, climate change and food security are all interconnected at different scales. This study uses a novel global-to-local approach that combines an economic (Computable General Equilibrium or CGE) model with a spatially explicit land use model to capture change at the global, national and landscape level for the period 2010-2030 under three scenarios (see detail below). The five key findings of this study are:

- 1. Land Use Change:** Economic development and structural change will lead to considerable change in land use under each of the three scenarios. Production forest land and built up land will expand at the expense of paddy rice area, non-production forest, and shrub land.
- 2. Food Security:** In both of Viet Nam's major rice production areas, the Red River Delta and the Mekong River Delta, large areas of paddy rice disappear under each of the three scenarios due to the expansion of built up land, particularly in the Red River Delta. However, the available land for paddy rice in 2030 is still slightly larger than the 3.8 million hectares of rice land that is set as the target to meet domestic consumption and fulfil export demand in 2020 (note that the paddy rice area in the spatial land use data used in this analysis is higher than the aggregate values published by MARD, casting significant doubt on this conclusion). In any case, paddy rice area is expected to decrease in the future and maintaining at least 3.8 million hectares of rice land will require additional policy measures. These include better coordination and collaboration among major land managers such as MARD and MONRE, and the development of a consistent land classification dataset that harmonises the different sources of spatial data in Viet Nam.

This is an extract from a detailed report on the same topic prepared by Van Dijk, M. (LEI-WUR), Hilderink, H. (PBL), Van Rooij, W. (Aidenvironment), Rutten, M. (LEI-WUR), Lan, V.C. (MARD), Kartikasari, K. (LEI-WUR), and Ashton, R. Please see the detailed report for sources and further information (www.lei.wur.nl/UK/).

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3. **Flooding:** In addition to economic development, flooding induced by climate change poses a serious threat to rice production in Vietnam. In particular, the paddy rice fields in the low-lying Mekong River Delta and, to a lesser extent, the Red River Delta are susceptible to floods. This results in a risk to domestic food production and international rice trade. To meet the food security paddy rice target, policies are needed that safeguard the paddy areas for flooding.
4. **Climate Change and Biodiversity:** Demand for land and forest resources will also put pressure on special use forest. In the absence of countervailing policy measures, the loss of rich, mostly natural forest, will threaten biodiversity in Viet Nam, and deforestation will contribute to greenhouse gas (GHG) emissions. Policies are needed that ensure protection of non-production forest and protected forest.
5. **Policy Trade-Offs:** Land use policy trade-offs are necessary to mitigate conflicts, for instance reducing land use for rice and increasing forest areas so as to reduce GHG emission will affect food security negatively unless rice yields or rice imports increase.

Decision makers in Vietnam need to be aware about the complex and uncertain relationships between global and local drivers of socio-economic change, and take a forward look when formulating food security and climate change mitigation and adaptation policies. As such this study presents a scenario and modelling approach that can support the development and implementation of the national Green Growth and REDD strategies. Nonetheless, the results of this study must be regarded as a first approximation of possible future pathways for socio-economic development and land use change in Vietnam. Only three scenarios are analysed, while many more futures may be relevant. For example, this study has not assessed the impact of trade policies (e.g. the EU-Vietnam Free Trade Agreement that is currently being negotiated) that can have major consequences for economic growth and development.

This study addressed the first two main research questions in detail (see above). However, the issues related to the third question – food security and climate change – proved much more difficult to answer, mainly due to the lack of relevant data. Useful follow-on work includes:

- **Climate Change:** Linking (spatially explicit) emission data for the agricultural, manufacturing and services sector to this analysis to produce detailed approximation of GHG emissions and sequestration from industrial activity and land use change under each of the three scenarios. In this study, such analysis was limited to emissions from rice production (using national average emissions factors for rice and rice straw burning).
- **Food Security:** Linking household data on poverty and income to this analysis to produce a detailed understanding of impacts on food security at the micro-level level. LEI-WUR and partners are currently implementing such an approach for a number of developing countries in the Food Secure project (<http://www.foodsecure.eu/>).
- **Biodiversity:** Linking a biodiversity model / map to this analysis to show the impact on biodiversity under each of the three scenarios.

Although scenario analysis and models can be a very powerful tool to assess the trade-offs between policy options, they remain a simplification of a complex reality and outcomes are heavily rely on the quality and coverage of available data. A key area of improvement is the Vietnamese land cover and land use data, which exhibit a number of inconsistencies. In particular, there is a need to develop one consistent classification system that harmonises the different sources of spatial data in Vietnam. Future research is also needed on the modelling of the land allocation, especially forest land, in CGE models. This should be borne in mind when interpreting and using the statistics and maps that are presented in this report.

Context: Why Land Matters for Vietnam

Land plays a crucial role in the development process of Vietnam. Not only does the agricultural land using sector in Vietnam account for a substantial share of GDP (approximately twenty per cent including forestry and fisheries), a large part of the Vietnamese population (over sixty per cent) resides in rural areas, mostly consisting of poor and small-scale farmers involved in the production of paddy rice, making the agricultural sector key to poverty reduction and food security. Food security is a concern since, even though Vietnam is the second largest exporter of rice, many rural households are net buyers of food. Vietnam experienced one of the fastest increases in food prices in early 2008, and, consequently, has been classified as one of the hunger hot spots in Asia and the Pacific (<http://www.foodsecurityportal.org/vietnam>).

SEDS (2011-2020) and Agricultural Development Plan to 2020 and Vision to 2030

Every ten years the Vietnamese government develops a Socio-Economic Development Strategy (SEDS), which outlines the long-term development objectives for the country. The most recent SEDS covers the period 2011-2020. The document is supplemented with the Agricultural Development Plan to 2020 and Vision to 2030, which describes the detailed plans for the agricultural sector, including land use projections.

The overall goal of the SEDS is turn Vietnam into an industrialised country with a stable social and political setting where living conditions have substantially been enhanced.

Key economic, cultural and social, and environmental objectives are:

- GDP growth rate of on average 7-8% per year
- Income per capita will reach about USD 3,000
- The total share of agriculture will be around 15% and that of industry and services 85%
- Share of agricultural labour will be 30-35%
- Urbanisation rate will reach 45% (55% in 2030)
- Human development index (HDI) will reach the average high-income group in the world
- Population growth of 1%
- Forest cover reaches 45%
- Access to clean water for most of the population
- Protection of the environment and improvement of environmental quality, active response to climate change, control and prevention of natural calamities

Land use by agriculture and forestry sectors and changes in land use patterns over time also play a crucial role in climate change mitigation and adaptation. Climate change concerns have risen of recent since Vietnam has enjoyed very rapid GDP growth, averaging six to eight per cent over the last decade, resulting in an exponential increase in GHG emissions. For 2000, total emissions in Vietnam were reported to equal 151 million tons of GHG in carbon dioxide equivalent (CO₂e), of which fifty-three per cent was attributable to agriculture and land use change, of which over half in turn was accounted for by rice (MONRE, 2010).

Whilst Vietnam's GHG emissions are relatively low in the global context, they are expected to continue to grow rapidly and will likely triple by 2030 unless significant mitigation options are undertaken. Vietnam is considered to be a high-risk country in the context of climate change because of its delta structure and the long coastline that is sensitive to flooding and extreme weather events. This makes the rural population increasingly vulnerable in terms of poverty and food security.

The Vietnam government has demonstrated its commitment to combat climate change by signing Decision 3119/QĐ-BNN-KHCH in December of 2011, which confirms the country's commitment to increase agricultural production by twenty per cent and reduce emissions and poverty by twenty per cent by 2020. The Vietnamese government is currently also in the process of drafting a Green Growth strategy and completed the final approval of the Reducing Emissions from Deforestation and Forest Degradation (REDD) program document, which is now in the inception and implementation phase.

Land use patterns in Vietnam are expected to change dramatically over time as a consequence of several global and local processes that interact at various scales and domains. Next to climate change, key global drivers that will affect land use in Vietnam are technological change, population growth and international trade. At the national and local level, spatial policies that ensure the safeguarding of areas with rich biodiversity but also climate adaptation and mitigation strategies

(i.e. REDD), expansion of urban and industrial zones and food security policies such as a mandatory allocation of land for the production of paddy rice will have important consequences for land use. Some of these policies may be conflicting. For example, reducing land use for rice and increasing forest area so as to reduce GHG emissions will affect food security negatively unless rice yields rise or rice imports increase.

The interplay between global and local drivers is complex and uncertain which makes it difficult to predict their impact on the economy, on landscapes, rural livelihoods and the environment. To formulate pro-active policies and identify challenges and opportunities, decision-makers need information about potential land use and other, economic, outcomes in different situations as well as insights about the underlying dynamics, potential trade-offs and the potential impact of policies. A popular approach to assess the future of complex systems and identify policy alternatives is to implement scenario analyses using (a combination of) models. A study of global-to-local land use impacts possess certain challenges as an integrative assessment is needed at different scales:

- The global-to-national scale examining the interplay between macro-economic factors, population growth and climate change
- The national-to-local scale which demands a spatial analysis at high levels of resolution

Methodology in Brief: A New Approach

This study applies an innovative assessment method, which integrates a global macro-economic Computable General Equilibrium (CGE) model with a 'local' spatial land use allocation model to analyse future land use patterns in Vietnam under various scenarios. The methodology used in this study is designed to quantify the impact of both global and national drivers and policies on land use in Vietnam up to 2030 using a number of scenarios. It builds upon the innovative work of Verburg et al. (2007) to model land use dynamics in Europe under various scenarios. This study presents the first application to a developing country.

It adds to the existing CGE studies on Vietnam that have generally focused on the economic impacts of trade liberalisation, with a few focussing on the environment and natural resources (World Bank, 2010). These studies, however, only use an economic modelling approach thereby unable to derive impacts at the landscape level and missing out potentially important feedback effects (e.g. areas that become more vulnerable to climate change are likely to become less food secure). Similarly the national scope of these studies misses out important global effects (e.g. via the channel of trade). Our study also contributes to existing modelling studies in terms of improving country data for Vietnam, most notably data and projections for land use and improved modelling of the land market.

A final contribution lies in the participatory approach via which the scenarios carried out in this study have been formulated. Specifically two workshops were held which informed the model set up, data used and construction of the scenarios to be analysed.

Limitations of Existing Land Use Maps

Additional and spatially disaggregated data were collected for this study to improve the land use data for Vietnam. However, a major problem is the inconsistency in the classifications and methods between the two sources of land use information: the Forest Inventory and Planning Institute (FIPI) under the Ministry of Agriculture and Rural Development (MARD) and the Ministry of Natural Resources and Environment (MONRE), which present a land cover map and a land use map respectively.

The most recent FIPI land cover map is for the year 2007 while the MONRE land use map is available for 2005 and 2010. A detailed comparison found inconsistencies between the MONRE digital maps on the one hand, and the FIPI map and the land use survey data that accompanies the MONRE land use map, on the other hand.¹ For this study the FIPI-map is preferred over the MONRE-map because the latter is more in line with other land use sources for Vietnam.

Both MONRE and MARD have acknowledged the need to create one integrated national land classification system but progress has been limited.

Three scenarios for the period 2010-2030 are implemented:

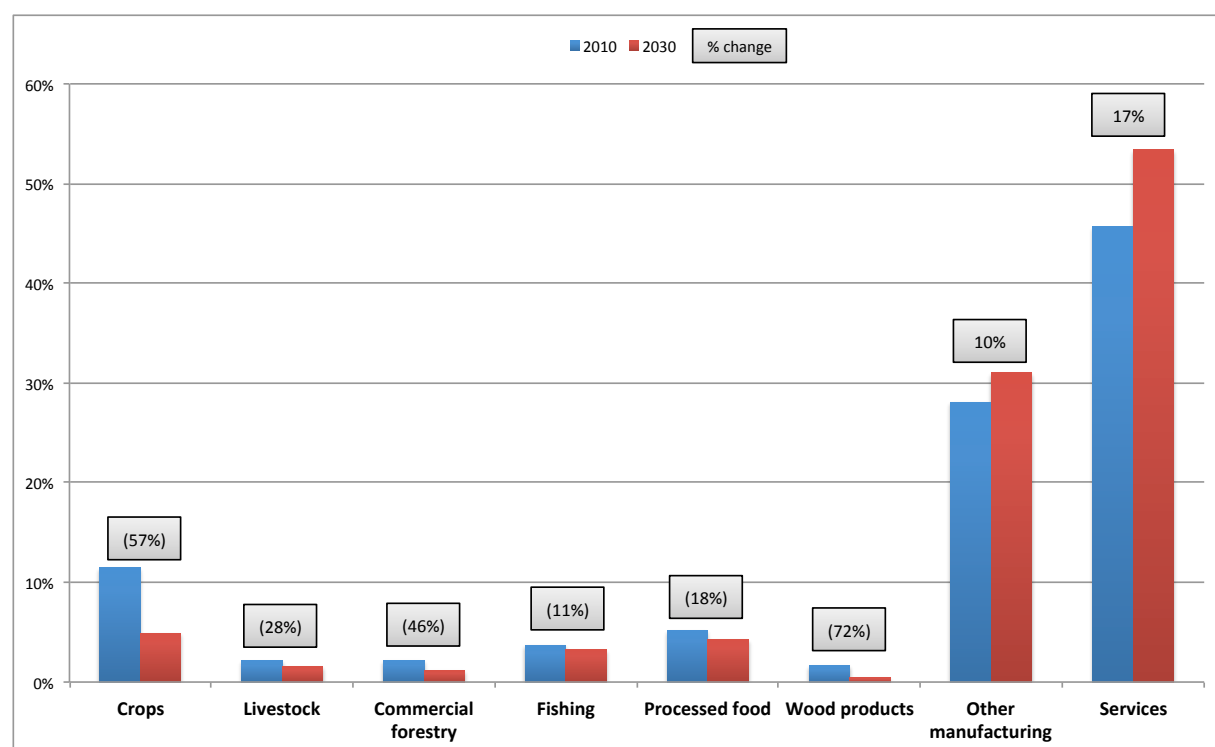
- The baseline scenario reflecting the '**Business As Usual**' (BAU) and simulates an economic growth path for Vietnam and the rest of the world assuming no implementation of new policies
- The **High Climate Impact (HCI)** scenario that reveals the consequences of climate change on Vietnam's economy and land use (modelled primarily through yields)
- The **High Economic Growth (HEG)** scenario which implements the growth target incorporated in the Socio-Economic Development Strategy (SEDS, 2010) of Vietnam and yield targets of Vietnam's Agricultural Development Plan (NIAPP, 2011) and demonstrates the consequences for Vietnam's economic structure and national and local land use

The outcomes can be compared with economic targets, and targets for land use and the agricultural and forestry sectors envisioned by aforementioned plans.

Results

Socio-Economic Development

Value Added Generated in Vietnam by Broad Economic Sectors (BAU): 2010 and 2030



Under all three scenarios Vietnam will go through a process of profound structural transformation in which the economy becomes increasingly oriented towards services and manufacturing while the agricultural sector becomes less important. This growth pattern is a continuation of the rapid development that Vietnam experienced over recent decades and comparable to the experience of other emerging economies such as South Korea and Taiwan in the 1980s and the present China. Despite the declining relative importance of agriculture in the economy, the sector still grows and Vietnam continues to be one of the main exporters of rice in the world in 2030.

Climate change has a negative effect on economic growth in Vietnam, in particular in the agricultural sector and the rest of the world. It causes a slowdown in Vietnamese economic growth by 0.2 percentage points per year in comparison to the BAU scenario. In the HEG, the reverse is observed; all sectors expand in size, especially agriculture in which technical change results in higher yields. The finding of economy-wide contraction (HCI scenario) and expansion (HEG scenarios) demonstrates the importance of input-output linkages between different sectors in economic growth and international trade. Climate change will both direct and negative effects on agriculture but also, through price and market linkages affect the development of the manufacturing and services sectors.

Landscape Level Outcomes

Overview

The agricultural wide effects of climate change and economic growth result in very similar (spatial) land use change patterns between the three scenarios. One major difference is the assumption of rapid urbanisation that leads to a substantial expansion of built up land in the HEG scenario. However, all scenarios show a considerable change in the landscape over time.

Structural change and economic growth is accompanied by an increase in the demand for wood resources, which causes an expansion in production forest land at the expense of non-production forest and grass and shrub land. At the same time, changing diets and an increase in yields leads a decrease of paddy rice land and other agricultural land, which are replaced by urban and industrial areas.

Future land use maps reveal that the land use changes are not distributed evenly over the country; most of the urban growth is concentrated in the suburban areas of the Red River Delta resulting a substantial decrease in paddy rice area. Also in the Mekong Delta expansion of urban land leads to a loss of paddy rice fields, concentrated around the borders of Ho Chi Minh City. The growth of production forest area mainly takes place in the North Central Coast, Central Highlands and South Central Coast regions at the expense of non-production forest but also shrub and grass land.

The production forest area shows the biggest absolute increase of all land uses, from 22 per cent of the total land area in 2007 to around 31 per cent in 2030 equivalent to a growth of 34-41 per cent, depending on the scenario. This goes mostly at a cost of various other land classes, mainly non-production forest (share falls from 19 to 16 (BAU and HCI) and 10 (HEG) per cent), paddy rice area (share falls from 16 to 12 per cent) and shrub and grass land areas (share falls from 19 to 15 per cent). Built up land increases substantially in the BAU and the HCI scenarios (share increase from 3 to 5 per cent) but most in the HEG scenario (up to 8 per cent) indicating a high degree of urbanisation. The Other land class remains constant throughout the period of analysis.

The HEG scenario pointed out that almost half of the forest in nature reserves, Ramsar sites and World Heritage sites (i.e. special use forest) will be lost if protection is lifted. The expected conversion of non-production forest to production forest that characterises all scenarios, and especially the loss of protected forest areas, will have serious consequences for biodiversity in Vietnam.

A striking development is the expansion of built up land in the Red River Delta and, to a lesser extent, the Mekong Delta.

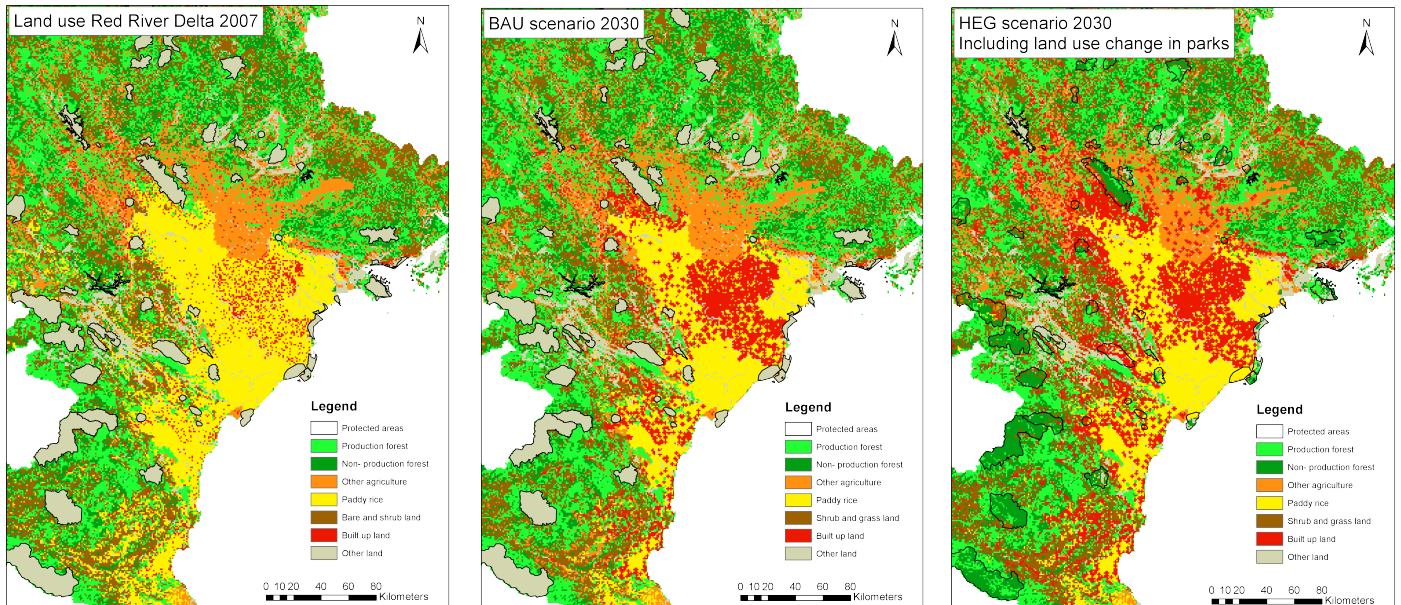
Zooming in on the Red River Delta and the Mekong Delta

The Red River Delta and the Mekong Delta are key economic and agricultural regions in Vietnam. The Mekong Delta, sometimes referred to as the 'rice bowl' of Vietnam is responsible for about half of total paddy rice in Vietnam with the Red River Delta adding another 15 per cent. The regions are

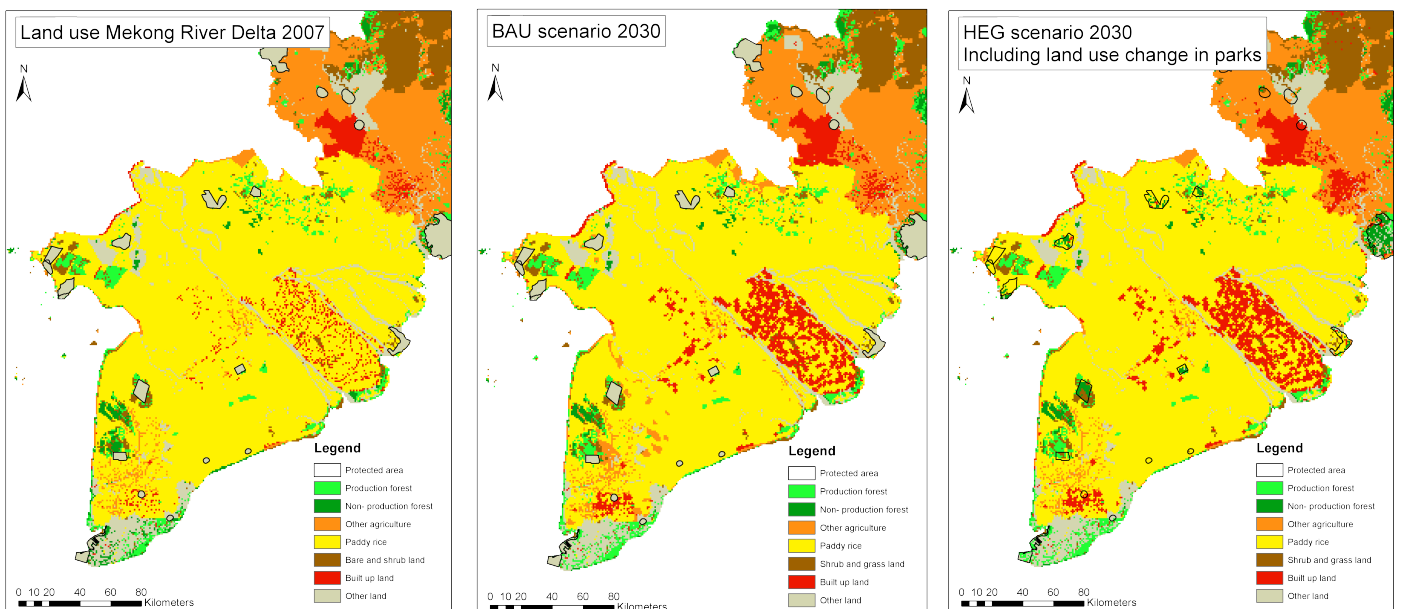
therefore of crucial importance for domestic food production and rural employment as well as international rice trade, given that Vietnam is the second largest exporter of rice in the world.

Land Use Change: 2007-2030

Red River Delta



Mekong Delta



Source: FIPI map 2007, BAU and HEG 2030 land use scenario maps.

Note: As there is limited difference between the BAU and HGI land use maps, the latter is not depicted.

The Red River Delta and the Mekong Delta are also core urban and industrial regions, clustered around the four largest cities in the country, Hanoi and Hai Phong in the North, and Ho Chi Minh City and Can Tho in the South. Both Delta regions accommodate one third (about 10 million) of the total national urban population (World Bank, 2011). For these reasons it is relevant to zoom in on the land use maps of the Red River Delta and the Mekong Delta.

Both regions show a major expansion in built up land between 2007 and 2030 in line with expected urban population growth in Vietnam and the four abovementioned cities (UNDESA, 2012). The growth of built up land in these regions is driven by factors such as the presence of infrastructure and proximity to populated areas and flat terrain. Between 1999 and 2009, the Red River Delta has witnessed a very high pace of industrial activity that led to an expansion of urban land throughout the region, probably caused by its proximity to massive Chinese industrial centres. The new industrial areas are predominantly located in suburban areas at a distance of about 70-140 km from Hanoi, not in the city centre itself. The Mekong Delta also experienced industrial growth but, in contrast to Hanoi, (heavy) manufacturing is located close to (distance of less than 70 km) the centre of Ho Chi Minh City. This leads to different patterns of built up land expansion in 2030. In the Red River Delta built up land growth is dispersed while in the Mekong Delta expansion is heavily concentrated around Ho Chi Minh City but also in some areas of the Mekong Delta. This pattern is even more pronounced in the HEG scenario where the rate of urbanisation is much higher.

In both regions, large areas of paddy rice disappear due to the expansion of built up land. This effect is particularly strong in the Red River Delta and directly related to the specific development trajectory of Hanoi and surrounding industrial areas. In the HEG scenario, urbanisation also leads to the conversion of other agricultural land. In the Red River Delta, agricultural land is lost in the Northern region, while in the Mekong Delta, the expanding borders of Ho Chi Minh City encroach on agricultural areas.

Deforestation in Protected Areas

A specific feature of the HEG scenario is the opening up of National parks, Nature reserves and World Heritage sites for commercial logging and agriculture. This means that so-called Special Use Forest (i.e. non-production forest in protected parks) that is located in these areas will be negatively affected. In 2007 the total area of Special Use Forest is 19,740 km², decreasing to 10,529 km² in 2030. In other words, 47 per cent of Special Use Forest will be lost in the HEG scenario due to economic pressure. Maps produced with this study show that deforestation will mainly take place in the protected parks that are located in the North Central Coast, Central Highlands and South Central Coast regions, where expansion of production forest is largest. The loss of rich, mostly natural forest, will threaten biodiversity in Vietnam. In addition, deforestation will contribute to GHG emissions unless it is compensated for by growing new forest to sequester carbon or other measures to mitigate climate change.

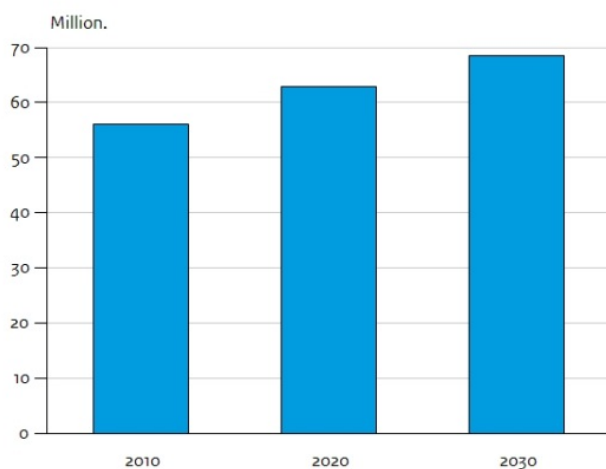
Climate Change

Impact of Flooding

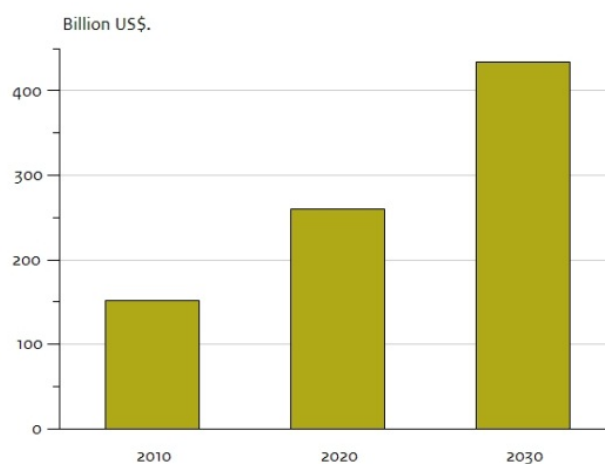
Climate change is shown to slow down the economy. The negative effect on yields causes agriculture (in particular crop sectors of paddy rice and vegetables, fruit and nuts) and associated processed food and wood product sectors to contract. By combining the future flood map generated under this study with spatial data on agricultural land, population and GDP, the people and assets at risk of flooding are determined. The analysis shows that in particular the Red River Delta and the Mekong Delta are threatened by floods, possibly jeopardising around 67 per cent of the total population and more than USD 400 billion in assets. Also up to 32 per cent of built up land, 47 per cent of paddy rice areas and 32 per cent of other agricultural land might be affected. These findings confirm the results of Dasgupta et al. (2009) that Vietnam is highly vulnerable to climate change and especially sea level rise and flooding.

People and Value at Risk by Floods in Vietnam (2010, 2020, 2030)

Population in Vietnam at risk by floods



Value in Vietnam at risk by floods



Greenhouse Gas Emissions from Land Use Change

A case study is presented to assess climate mitigation options for paddy rice – the largest GHG emitter in the agricultural sector. The contraction in paddy rice land between 2010 and 2030 will already lead to a 22 per cent decrease in GHG emissions. A further reduction of between 14 and 19 per cent can be achieved by improving agricultural practices and restrict the burning of rice straw. The analysis can be greatly improved by combining the future land use maps with spatially explicit GHG conversion factors.

With the combination of models used in this study, it is possible to provide detailed projections for GHG emissions under different scenarios. The CGE model can be linked with a specially designed emissions database to estimate GHG emissions for agriculture, manufacturing and services sectors. GHG emissions for agriculture, and in particular land use change depend strongly on bio-physical characteristics of the landscape, management practices and land use change dynamics. Estimations can be refined by combining spatially explicit information on above and below carbon stocks with future land use maps such as presented above. It is out of the scope of this study to provide an in-depth carbon emissions assessment. Instead, some preliminary aggregate results are presented to illustrate how the results of this study can be used for the analysis of climate change mitigation options. At the time of writing of this report, IFPRI is undertaking such a project, analysing the impact of emissions strategies and options for a number of crops and livestock sectors under different scenarios. It will be interesting to compare their findings with the results of this study.

Food Security

At the macro-economic level food security, measured as the change in food consumption, improves in the BAU scenarios as food becomes cheaper. Like in other emerging economies, growth in income per capita is accompanied by a change in diets from rice to processed foods. These findings are even more pronounced in the HEG scenario. In both scenarios, the exports of processed rice to Sub Saharan Africa expands substantially, thereby positively contributing to food security in the region. In the HCI scenario, food security in Vietnam and the rest of the world deteriorates due to a rise in food prices. As mandated by the Resolution on National Food Security (No. 63/NQ-CP), Vietnam must keep at least 3.8 million hectares of rice land to meet domestic consumption and fulfil export demand in 2020.

Despite the substantial decrease in paddy rice land this target is not jeopardised in any of the three scenarios. However, it must be noted that the paddy rice area in the 2007 FIPI map is somewhat

larger than the area presented in the statistics published by MARD which is often used as official reference. Using this statistic and assuming a similar contraction in the paddy rice sector, it is doubtful if the target of 3.8 million ha of rice land will be met. Moreover, the analysis strongly points out that structural transformation is driving the conversion of paddy rice land into built up land that is required for industrial expansion and urbanisation. This process is part of the economic development process of Vietnam and will continue in the future. Maintaining at least 3.8 million hectare of rice land will therefore require additional policies measures in the near future.

Selected Sources

- Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., Yan, J., 2009. The impact of sea level rise on developing countries: a comparative analysis. *Climatic Change* 93, 379–388.
- MONRE, 2010. Viet Nam's second national communication to the United Nations Framework Convention on Climate Change. Ministry of Natural Resources and Environment, Hanoi.
- NIAPP, 2011. Agricultural Development Plan to 2020 and Vision to 2030 (original version in Vietnamese). Hanoi.
- UNDESA, 2012. World Population Prospects: The 2010 Revision and World Urbanization Prospects: The 2011 Revision [WWW Document]. URL <http://esa.un.org/unpd/wup/index.htm>
- Verburg, P.H., Eickhout, B., Meijl, H., 2007. A multi-scale, multi-model approach for analyzing the future dynamics of European land use. *The Annals of Regional Science* 42, 57–77.
- World Bank, 2010. Economics of Adaptation to Climate Change: Vietnam. The World Bank Group, Washington, D.C.
- World Bank, 2011. Vietnam urbanization review: Technical assistance report. Hanoi.