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Vulnerability of rice farming to extreme events in the context of transition to a market economy in the Red River Delta / Viet Nam

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Contents

1 Introduction

The aim of this study is to outline a conceptual model of the vulnerability of rice-based rural communities in the Red River Delta to extreme events. This assessment focuses on the socio-economic aspects of the system.

1.1 Study area / system description

Viet Nam is a land of geographical contrasts, situated in the East Sea (South Chinese Sea) and bordered by China, Laos, and Cambodia. The climate varies from warm, moist tropical in the southern part of Viet Nam to moist tropical in the north where cold outbreaks from temperate latitudes during the winter months are usual.

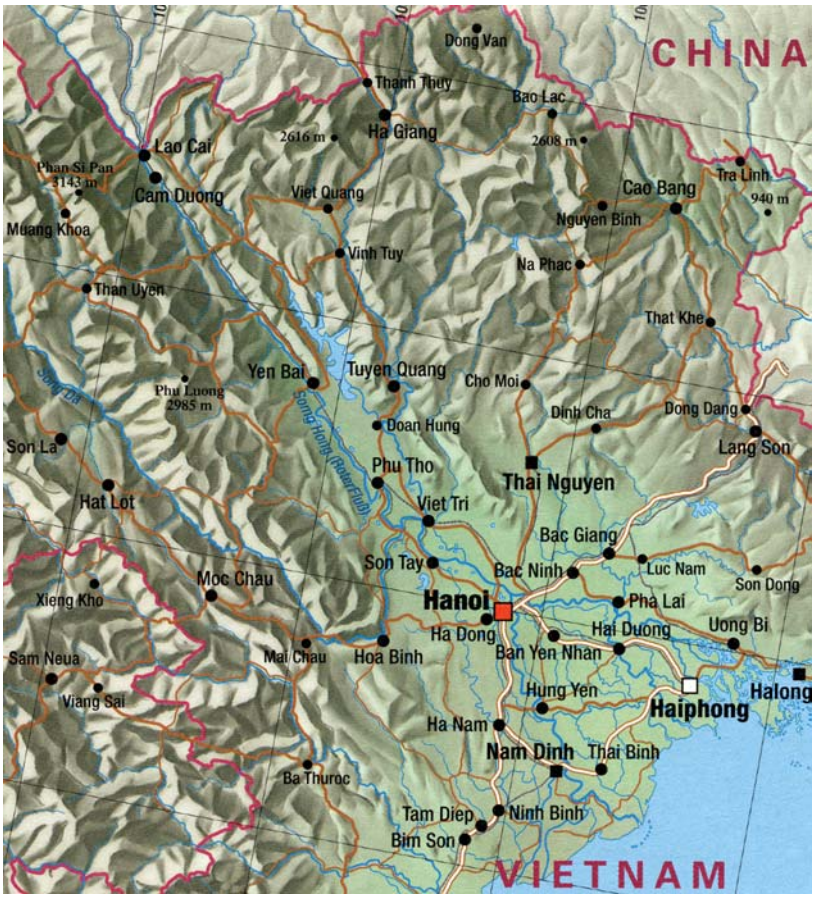

Figure 1: Study area with Red River (Somg Hong) and Halong Bay (see cover photo)

This study focuses on the Red River Delta, which is a fertile and densely populated agricultural region covering just less than 50,000km^2 in the northwest of Viet Nam. The population of this region is mainly rural (over 70% of the population) and relies largely on the ecosystem services provided by the Red River Delta and its surroundings. Most people are employed in agriculture, with rice as a major crop. Less important economic sectors are aquaculture and related activities.

1.2 Current situation

1.2.1 Ecosystems

The region includes a significant coastal zone where mangroves provide crucial ecosystem services

like coastal protection and biodiversity. Another important proportion of land is covered by water bodies, which form both important ecosystems as well as water supply for agriculture and industry.

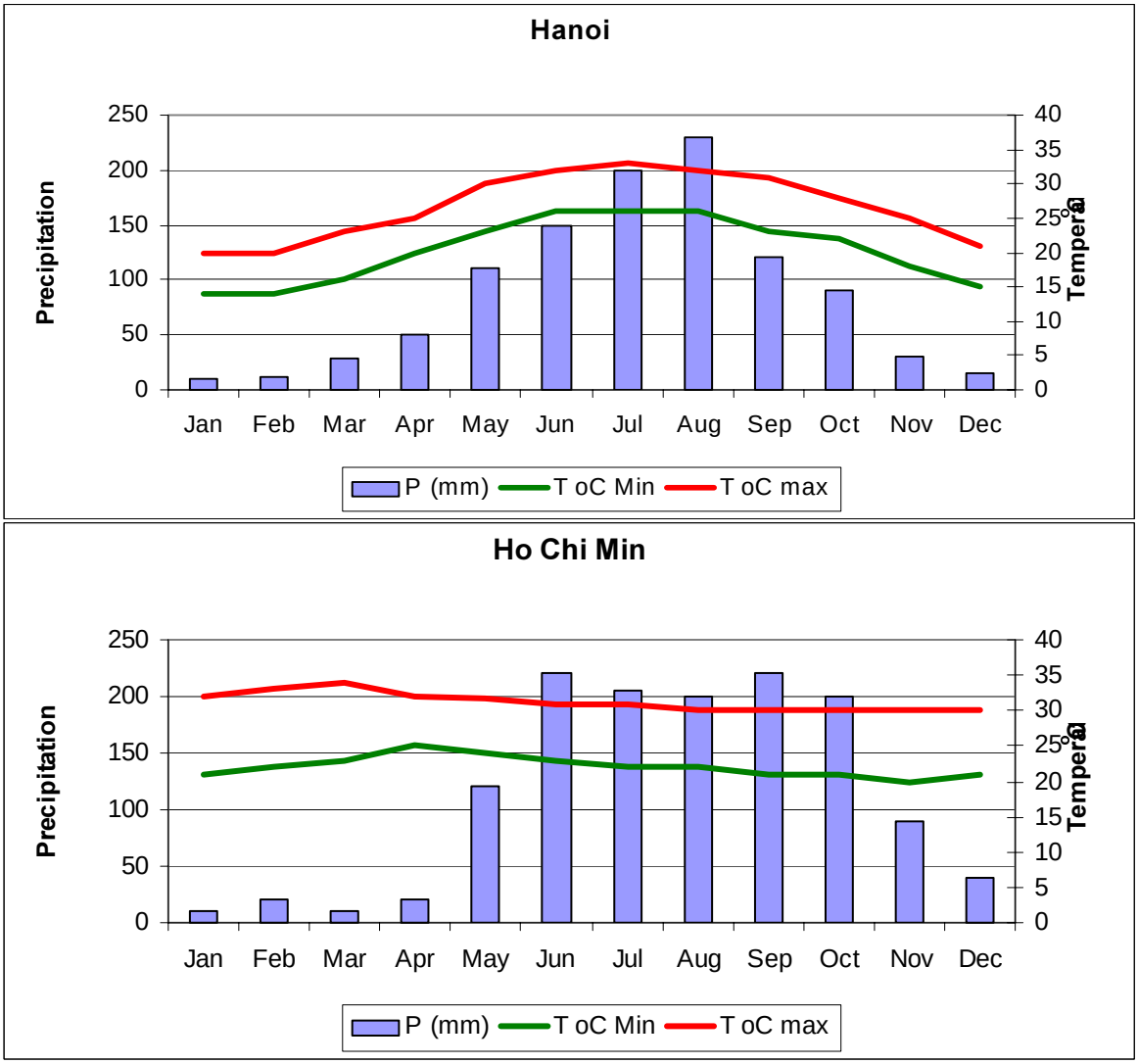

Figure 2: Seasonal cycle in monthly mean temperature (minimum and maximum) and total rainfall for Hanoi and Ho Chi Min City.

1.2.2 Society and economy

During the last decades this area experienced rapid changes with a growing urban industrialisation and population migration to the urban areas and particularly to Hanoi. This occurred in the context of the country's transition from a planned economy towards a market-based economy. Nevertheless, government strategies still place rural development at the centre of growth and regard it as a major issue in poverty reduction programmes.

Rice farming covers almost 70% of the total area of the Red River Delta and occupies close to 70% of the workforce of this area. It remains one of the major sources of export earnings. However, the rice-farming sector is undergoing rapid evolution. In the period up to 1981 it was based on a collectivised system where village-level cooperatives organised the labour allocation and distribution of external inputs and outputs.

The government introduced reforms in 1986 in order to modify the old structures, encouraging an agriculturally based economy. This, in turn, has been accompanied by changes in land tenure and

control. The current situation can be described as "decollectivisation", characterised by rapid increases in marketed agricultural outputs, incremental changes in the distribution system and higher real prices to farmers as well as incentives to invest in private agricultural land.

1.3 Extreme events

The study area is characterised by a monsoon climate with a hot rainy season and warm dry season. Many studies consider this region as highly vulnerable to extreme events due its topography and its proximity to the coast (IPCC 2001, UNEP 2001, FAO 2002). In fact, frequent typhoons from May to January strike this area, generating extensive flooding and considerable economic and social damage.

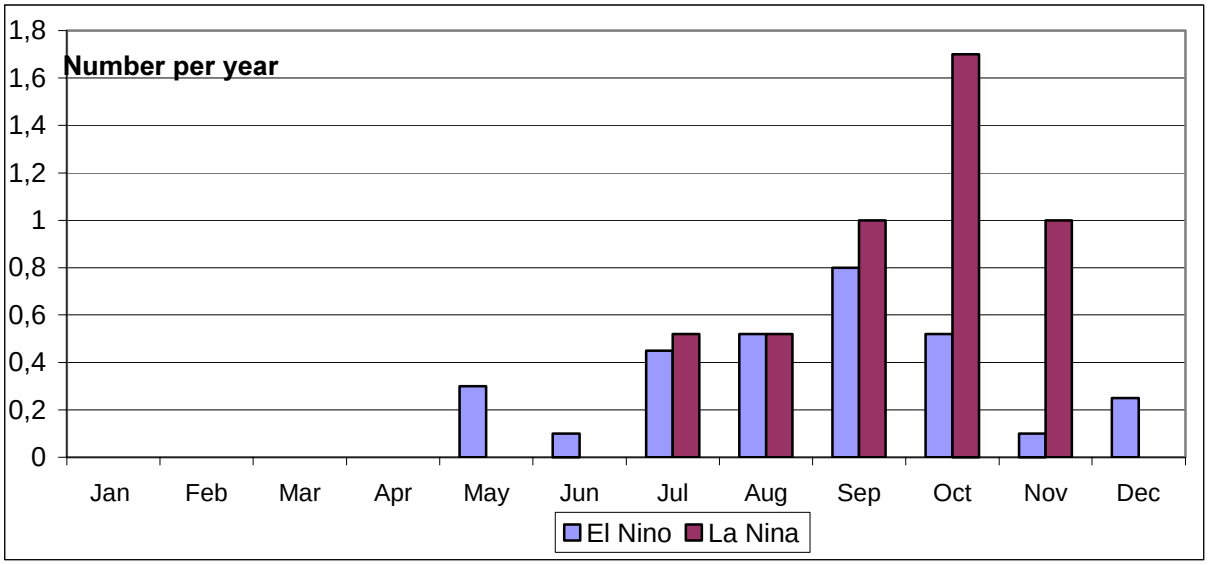

Figure 3. Seasonal cycle in typhoon frequency (average number per year in each month) in the area 7.5-22.5^{o} N, 100-115^{o}E for seven El Niño (blue) and seven La Niña (red) events.

The alternation between El Niño and La Niña events are an important cause of climate extremes that are affecting the Red River Delta. El Niño events affect the monsoon flow in this area, generating drought. When La Niña conditions prevail, storm frequency is notoriously increased. Additionally, heavy rainfall, saltwater and freshwater flooding, drought, heat waves and sub-freezing conditions are frequent hazards as well.

Tropical cyclones, which frequently hit the coastline and have the potential to cause considerable damage, are the major natural threat. This occurs primarily between May and December during El Niño events or between July and November during La Niña events (See Figure 3). Viet Nam has great experience in protecting itself from natural hazards like typhoons or tropical cyclones. As an adaptation measure an institutional network has been set up which acts as an early warning system.

One example of the impact of typhoons on rice production in Xuan Thuy from 1981-1995 can be seen in Figure 4. The radical increase in agricultural production over the 16-year period considered coincides with the liberalisation of agricultural production and distribution of land leases to individual households. The impact of the major storms which have crossed the coast close to this district over the period can be seen to have had significant effects on agricultural production, at least in 1986 and 1994. There is, however, little evidence of any impact on agricultural production due to the 1992 storm.

2 Methodology

2.1 Conceptual framework for vulnerability assessments (VA)

2.1.1 Concepts and definitions

At the beginning of our group work we had intense discussions about the appropriate terminology. This reflected our uncertainty regarding the proposed definitions (of exposure, sensitivity, adaptive

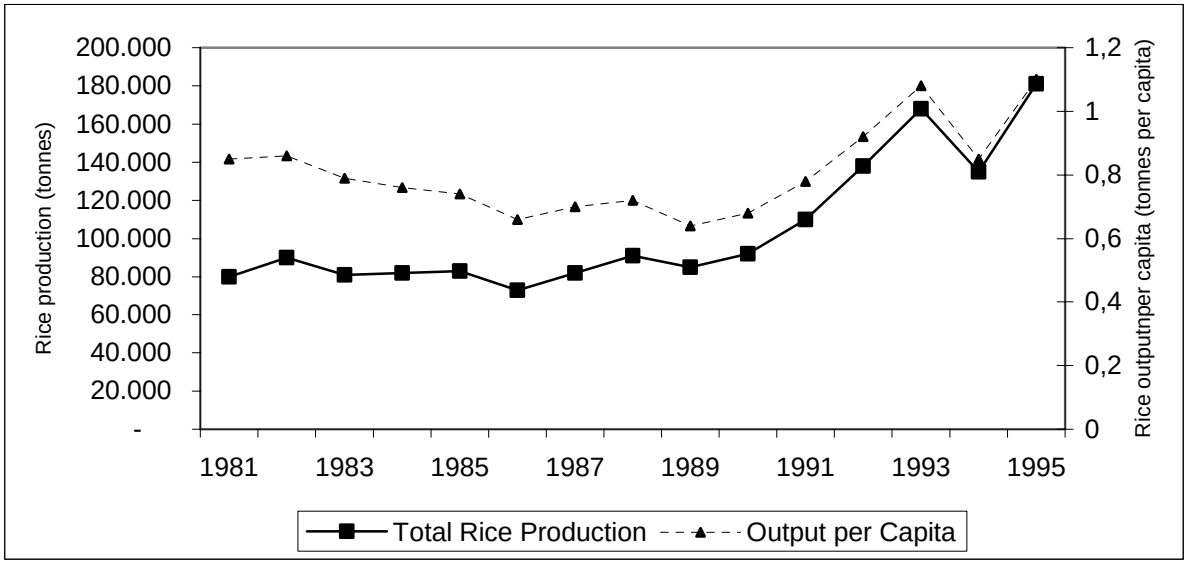

Figure 4: Total rice production and production per capita for Xuan Thuy District and the timing of major storm events in the period 1981-1995.

capacity and vulnerability). We thought that we ought to be sure about these terms before going any further. After a long discussion we agreed upon the following definitions, which also form the basis of our conceptual framework (2.1.2):

- **Exposure:** if a certain threat is present: this is the likelihood of it to happen (sea-level rise, extreme events...).
- **Sensitivity:** the response to this threat. This is the likelihood of impact: the probability that a consequence will happen if exposure occurs (e.g. land-area loss in case of sea-level rise).
- **Adaptive capacity:** possibility of avoiding the threat or adapting to the threat.
- **Impact:** I=f (E, S): the effect of a certain threat which is determined by exposure (if the threat is present) and sensitivity (the effect the threat causes if materialises).
- **Vulnerability:** the degree to which a system will respond to a certain impact (V=f (E, S, AC)) taking into account possible adaptive strategies to lower the impact.
- **Vulnerability assessment:** assessing the vulnerability of a given system throughout multiple possible futures (scenarios).
- **Impact assessment:** one possible future: differentiated from vulnerability assessment by the question of likelihood.

2.1.2 Diagram

As soon as we had defined the important terms, we had difficulty deciding how to go on. Which question should we focus on? What are the interesting issues in our study area? How should we define the study area? We decided to carry out a stakeholder involvement role-play to answer our questions and redefine the boundaries of our study (see 2.3). From the stakeholder role-play we derived insights

into what the most interesting research issues could be. We decided to rescale our study from the national to the regional level and focus solely on the Red River Delta. Then we built our conceptual framework. We divided the group into two: one subgroup focused on indicators which could be useful for our study (see also 2.2) while the other focused on the kernel of the conceptual framework: a causal loop diagram which was created during a brainstorming session on a flipchart and later enhanced. Afterwards we put it all together and simplified the diagram (see Figure 5).

We defined two major groups of exposure (global climate change related events and global economic processes) which affect our system of study from the outside. The feedback on these from driving forces inside our system is not taken into account. The human-environmental system shows sensitivity to these exposures. It is possible for the human (socio-economic) system therein to adapt in order to react to certain impacts. This adaptive capacity is influenced by the state of the socio-economic system, which is established as a function of a variety of internal factors (political system, public wealth, ...) and influenced by external factors (international economics and policy, …).

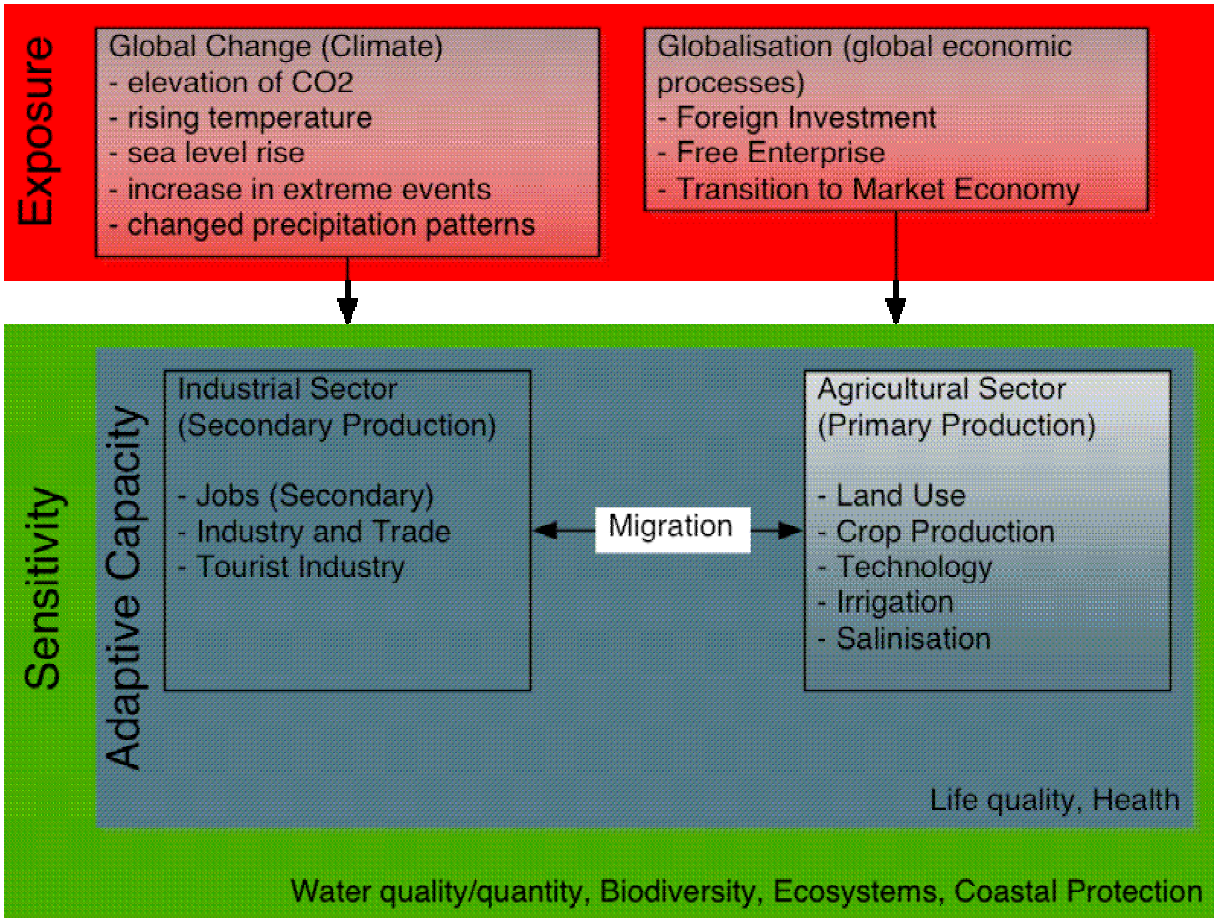

Figure 4: Conceptual framework, the whitish box with the Agricultural Sector includes the community under study (for discussion see text)

2.1.3 Community under Study

This case study focuses on the **rice farming-based communities of the Red River Delta** for several reasons. On the one hand, we felt that we should narrow our study region as well as the community considered. On the other hand, rice-based farming employs 75% of the inhabitants of the region and is the backbone of the economy of Viet Nam. Furthermore, river deltas are the regions, which will experience the most serious impacts in the case of dramatic climatic changes (sea-level rise, increase in extreme events, elevated temperature, changed precipitation patterns).

2.2 Indicators

After developing our conceptual framework, we tried to find indicators which could describe and be used to measure changes in the parts of our system quantitatively. As mentioned above, we divided the group into two to speed up the work. When we later came together again, we had to face a huge number of indicators and so we broke them down in two steps (see Section 2.3 for details). The indicators can be categorised according to their relation to the terms exposure, sensitivity or adaptive capacity. Nevertheless, these indicators are often applicable to more than one of these terms and the assignment to any one of them depends on specific thresholds. One example: the area which is lost due to sea-level rise is an indicator of exposure (in every case). When land loss through sea-level rise reaches a certain threshold, it can be considered as an indicator of sensitivity as well.

Table 1: Quantitatively measurable indicators with information on units (first parenthesis) and on their allocation to the terms exposure (e), sensitivity (s) and adaptive capacity (ac) in the last parenthesis. The thresholds cannot be considered here and have to be ascertained (in a real study) together with stakeholders

> Mangrove
• total area (ha) (e, s)
> Coastal Erosion
• lost area (per year) (ha/a) (e, s)
> Extreme Events
• Storm frequency (events/year; days/year) (e)
• Flood frequency (events/year; days/year) (e)
• Intensity (Water height, flooded area) (e, s)
> Health
• Access to health service (inhabitants/doctor(hospital: number of beds per thousand inh.) (ac)
> Water quality/quantity
• water consumption per "user" (m^3/yield, m^3/sectoralGDP) (s, ac)
> Irrigation
• total cultivated area under irrigation (s, ac)
> Migration to City
• migration rates (Δ of inhabitants in rural areas, Δ of inhabitants in urban areas, birth rates, mortality rates) (ac)
> Crop production
• area (s, ac)
• production (tons/year) (s, ac)
> Life quality (rural/urban)
• income (s, ac)
• employment rate (and Δ) (s, ac)
> Land Use
• ratio of different land use (s)
> Industry/Trade
• Part of GDP derived from industry/trade (per capita and sector) (ac)
• International rice prices (ac)
> Public Wealth
• Government spending (s, ac)
• Import/export rates (s, ac)
• External debt (s, ac)

2.3 Stakeholder involvement

Vulnerability assessment must aim at a specific system, which includes closely interconnected environmental and human subsystems. To this aim, it includes both analysis of vulnerability and the identification of specific options for stakeholders to reduce that vulnerability (Polsky, et al. 2003).

Stakeholders are people and organisations with specific interests in the evolution of specific human-environmental systems (Polsky, et al. 2003).

As mentioned above, Viet Nam is in a stage of transition from a planned to a market economy. Under these circumstances, both international and national commissioners will be potential stakeholders. The former will care very much about the risk of environmental problems, public health, social welfare, etc. in relation to global change while the latter will perhaps be more concerned about income, living conditions, economic growth, etc. Due to the political system (socialist) the government plays a major role in the country's adaptation to global change.

To sample views on the study area on a broader scale, the first "stakeholders' dialogue" was organised. The stakeholders comprised the national head of the communist party and the representatives from international organisations such as the Red Cross, the FAO (Food Agriculture Organisation), the World Bank, a foreign company developing a particular rice-hybrid ("sea-level rice") to adapt to salinity intrusion. The main concerns of the international stakeholders were:

- to urge the government to improve farmers' living conditions, (especially sanitation);
- to encourage the government to draw up a sustainable policy regarding rice production, including technological development, land management, farmers' rights to land use, etc.;
- to encourage farmers to adapt to climate change and extreme events by changing crop types, using hybrids, using cropping calendars and crop rotation, diversifying crop production, etc.;
- to improve and foster local governance in the face of globalisation;
- to benefit from socio-economic and political changes, which has happened recently in the wider region and could bring economic development for Viet Nam as well;
- to emphasise the need to focus on delta regions and rice farming;
- to stress the problems of sea-level rise and hunger: the foreign company developing "sea-level-rice" has had good preliminary results with rice-hybrids which could be grown in salty water;
- to explore the interaction between sea-level rise and food supply (sea-level rise may affect crop yields and thus result in growing hunger in dependant populations).

The main concerns of the government (the national stakeholder) were:

- the welfare of the whole of Viet Nam;
- the impacts on ecosystem services needed for agriculture since most of the inhabitants live in deltas and rely on farming.

To obtain local opinions on the important research issues, a second stakeholders' dialogue was organised. The stakeholders were from the study area and comprised a new landlord, a rice farmer, a shrimp farmer, a rice trader, a manager from the public water-management division and a nature conservationist. Based on this discussion, indicators were determined (see above) to quantify the most important issues.

2.4 Scenario development

We chose to look at the vulnerability of rural farming communities to extreme events in the context of a transition to a market economy. At first we were faced with the problem of choosing between a "what if" approach and a local interpretation of global storylines (SRES). We finally chose a nested scenario approach, in which scenarios of social, political and economic change modified the farming systems and the adaptive capacity of rural communities. To each of these socio-economic scenarios we "applied" two climatic change scenarios that modified exposure to extreme events.

This results in eight possible combinations for climate and socio-economic change.

2.4.1 Socio-economic scenarios

The following scenarios are all "not implausible" scenarios of social, political and economic change affecting Viet Nam. They correspond to a gradient in the rate of transition from a planned to a market economy over the next 50 years. The last two scenarios (RP & RH) keep the present communist regime in place whereas the first two are scenarios within which the political regime changes (VN & VS). See Table 2 for a description of the direction (positive, negative, neutral) and rate (number of + and -) of change of selected drivers compared to the present-day situation. The drivers were selected during the description of our system of study using the "systems dynamics" approach.

Table 2: Scenario development: the direction of the development is expressed through the signs + (increase), - (decrease) and 0 (no change). The number of signs expresses the rate of change.

	VN	**VS**	**RP**	**RH**
Rate of Transition	**+++**	**+**	**-**	**--**
Governance				
local	-	+	++	0
national	-	++	+	+++
international	+	+	+	+
Foreign investment				
Agriculture	+++	++	+	-
Aquaculture	++	+	-	-
Others (industry and trade)	+++	++	0	-
Access to international markets	+++	+	+++	-
International demand (rice)	+++	+++	+++	+++
Domestic demand (rice)	+	++	++	-
Urban population	+++	++	-	0
Rural population	--	-	+	0
Equity	---	0	++	-
Public money	-	++	++	-
Technology adoption by present farming communities	0	+	++	-

Sensitivity analysis of socio-economic scenarios

In this section we describe the qualitative modelling we did to assess the sensitivity of the rural farming communities to changes of the above-mentioned socio-economic and political drivers.

- **Scenario RP: rice paradise (analogy with present day China but with a strong impact of technological innovation in agriculture)**

International rice demand increases strongly and Viet Nam is in a very favourable position because of the early adoption of effective production methods and technological innovation (new varieties of rice, GMO). This has given Viet Nam a very strong competitive advantage on the international rice market and this drives important land-use changes at the national level: irrigation increases strongly in the upland parts of the country, thus increasing national water demand. This leads to a diversification of lowland farming systems to increase the share of rain-fed crops (sugar cane is a popular rotation crop) because water quotas are set for each farm by a national water board. Dams are built to regulate water availability. A strong, centralised information system is set up to forecast water availability and is used to negotiate these water rights. High income in the farming majority decreases. Therefore social unrest decreases and the communist government increases public spending in education and welfare. Equity remains a major goal of governmental policy and is possible due to the strong economic development.

- **Scenario RH: Red Hell (analogy with present-day North Korea)**

In this scenario international rice demand increases strongly but Viet Nam is unable to participate because of an international embargo set up to weaken the communist regime. Social unrest increases because of lower income and the government responds with increasing use of force. Migration to cities is strictly controlled and this maintains the agricultural production systems in a chronic state of labour surplus. This in turn hinders the adoption of new technologies and land-management methods are not reformed in any way. Production targets are set-up to satisfy domestic rice demand but low productivity results in rice being the only crop almost everywhere and crop failure becomes a major issue. Foreign aid (Chinese in particular, but mainly private charities) helps to keep the system afloat.

- **Scenario VN: Viet-NOW! (analogy with post-communist Russia)**

As the communist regime collapses, governance decreases strongly and a ruthless free-market economy is set up. Peasants are driven into the cities as foreign agri-business companies buy important stretches of former public land to set up intensive, mechanised, labour-efficient farming structures. This provides cheap labour, leading to strong industrial developments but very precarious living conditions for the urban poor. Social unrest leads to increased street violence. Anti-capitalist terrorism develops and is combated by strong police control and restrictions on public freedom.
Shrimp farms develop strongly on the coastline, taking the opportunity of unidentified property rights and weak governance to expand without consideration of environmental impacts. Mangrove forests decrease strongly in area. Tourism does not develop as foreigners are afraid of political unrest.

- **Scenario VS: Viet-SLOW!**

In this scenario the transition to a market economy proceeds at a slower pace than in the VN scenario. A progressive transfer of governance from the national level to local levels takes place. Progressive change in the political regime means that no "power void" occurs and social structures do not collapse. Farming communities increase their capacity to respond to changes in prices and water resources (using a water rights attribution system at the local, provincial and national levels). Viet Nam responds to increasing rice demand by playing on its relative advantage in rice production and increases exports. Coastal areas fall under the jurisdiction of provincial governments that strictly control aquaculture development. Particularly exposed coastlines are designated as nature reserves and coastal protection schemes are established. As the country opens itself to commerce, increased foreign investment in trade and industry provide increasing employment opportunities in an urban context, leading to urbanisation and increased water and food demand by the Hanoi metropolis.

2.4.2 Climate change scenarios and exposure to extreme events

Climate change is a major driver of ecosystem change. In our study we consider 2 different climate change scenarios. They were downscaled from existing SRES-Scenarios.

No.	Climate Indicators	A1	B2
1.	Sea-level rise	5cm per year	0
2.	Precipitation	Increase10% from 87 mm/month	Increase 4% from 87 mm/month
3.	Temperature	0.05 ^{o}C per year	0.02 ^{o}C per year
4.	Extreme event period (ENSO)	increasing	no change

3 Results

3.1 Adaptive Capacity

In this study we only consider adaptation to extreme events. These events are typhoons with high winds and heavy rain potentially causing widespread destruction. The high rains and coastal storm surge also mean that there is an important flooding risk in coastal areas. The potential impact of

coastal surges covers a much smaller geographical area than that of strong winds, which reach further inland. Another form of extreme event is flooding caused by strong rains in the upper catchments of the Red river. The potential impacts of such floods are more widespread.

3.1.1 Possible adaptation measures

The flood risk increases closer to the coast. Presence of higher ground on which to take refuge and place valuables decreases at the same time. The land in the deltas of Viet Nam is very low lying, so that relocating people and activities is not a general option in any of our scenarios. Similarly, there is not much that can be done to protect against high winds except having an efficient early-warning system so that people can find shelter before the storm arrives. This means that for wind, rain and surge impacts of typhoons, good forecasting and efficient information channels to the rural communities are a major adaptation measure.

Evacuation routes and protocols as well as storm shelters are not easy measures to implement. What could be done, though, is to encourage elevated housing (piled houses). However, this form of architecture could be more sensitive to wind hazards. Moreover, after a typhoon, the most serious issues are health issues. Access to clean drinking water and food relief are of the utmost importance. The structure of the landscape can play a role in diminishing the speed of the flood-level rise and mangroves are generally recognised as playing a major role in lessening the intensity of storm surges. In the case of river floods, impacts are more widespread. Adaptation measures include accelerating the evacuation of water to "flood expansion" areas or to the sea while protecting other parts of the landscape. Dykes and river derivation canals are the typical options implemented. Many other options could be available and many more could become available in the coming 50 years.

It seems that forecasting and warning systems as well as health and food relief are the most important components of a country's adaptive capacity to extreme events. Governance and organisational resources are the main determinants of adaptation through forecast and warning. Financial resources have a strong impact on health and food relief.We chose to look at the evolution of mangrove protection as a component of the exposure of rural areas.

	VN	**VS**	**RP**	**RH**
Forecasting capability	Good	Average	Good	Bad
Information efficiency	Bad	Good	Good	Good
Forecast & information	Bad	Average	Good	Bad
Health relief resources	Average	Average	Good	Bad
Food relief resources	Average	Average	Good	Bad
Relief capability	Average	Average	Good	Bad
Adaptive capacity	Average	Average	Good	Bad

It seems that the four socio-economic scenarios induce very different adaptive capacities to extreme events. They could be ordered in the following way: RP > VS > VN > RH.

4 Conclusion

We discussed the vulnerability of rice-farming communities based on four not implausible socio-economic scenarios and based on two climate-change scenarios. We came to the conclusion that the political choices made by the Vietnamese people and/or their government will have a much larger impact on their vulnerability to extreme events than climate change itself.

This study was put together during a summer school. None of us was in Viet Nam, so that all we have collected and written here is based on literature and internet inquiry.

References

Akhlaghi, M., K. Bolt, et al. (2003). The Little Green Data Book 2003 - From the World Development Indicators 2003. Washington, International Bank for Reconstruction and Development / The World Bank.

CIA (2003). The World Factbook, CIA.

Davis, G. (2002). Scenarios as a Tool for the 21st Century. Information about the Royal Dutch/Shell Group of Companies Information about the Royal Dutch/Shell Group of Companies. London, Shell International Limited: 10.

FAO (2002). World Agriculture: towards 2015/2030 - Summary report. Rome, FAO: 106.

Geist, H. J. and E. F. Lambin (2002). "Proximate Causes and Underlying Driving Forces of Tropical Deforestation." Bioscience 52(2): 143-151.

GEO (2002). Outlook 2002-32. GEO World Development Scenarios.

International Centre for Integrative Studies (2000). Cloudy crystal balls - An assessment of recent European and global scenario studies and models. Environmental issues series No 17. T. Ribeiro. Copenhagen, European Environmental Agency: 113.

IPCC (2001). Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. R. T. Watson and the Core Writing Team. Cambridge, United Kingdom, New York, USA, Cambridge University Press: 398.

IPCC (2002). Climate Change and Biodiversity. Technical paper of the IPCC. H. Gitay, A. Suárez, D. J. Dokken and W. R. T. Genf, IPCC: 86.

Polsky, C., D. Schröter, et al. (2003). Assessing vulnerabilities to the effects of global change: An eight step approach. Environment and Natural Resources Program. Cambridge, MA, Belfer Center for Science and International Affairs

UNEP, C. Nellemann, et al. (2001). GLOBIO. Global methodology for mapping human impacts on the biosphere. UNEP/DEWA/TR.01-3. Environment Information and Assessment Technical Report. UNEP. Nairobi, UNEP: 55.