LAND USE AND VULNERABILITY TO FLOODING IN THE POYANG LAKE REGION OF CHINA

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CHINA DATA CENTER
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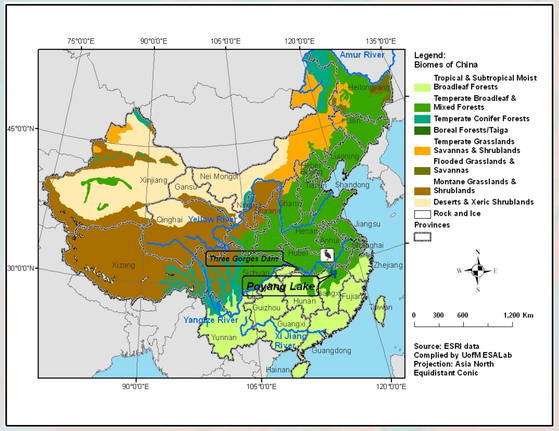
The Study Site



- A poor rural area in Jiangxi province of China
- Historically subjected to flooding from the largest fresh water lake in China
- A habitat for 332 species of birds, 13 under international protection

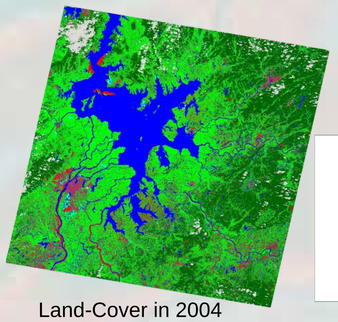
A Study of Land-Cover Change and Vulnerability at Regional Scale using Remote Sensing and GIS data

Our project

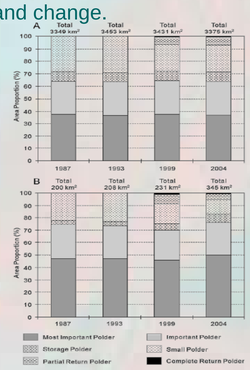
- Mapped land cover and change in the Poyang Lake Region using multi-temporal Landsat images at high and low water levels from 1987, 1993, 1999 and 2004;
- Analyzed factors that have likely influenced changes in land-cover patterns and
- Assessed implications of land-cover patterns for vulnerability to flooding based on the distribution of land covers relative to elevation and the levee quality.

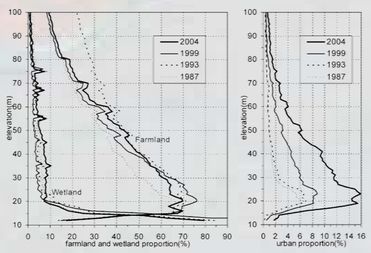
Approach:

(i) Unsupervised classification was performed with PCA, NDVI, NDWI, and Tasseled Cap bands to generate six general land-cover categories.
(ii) The probability of land-cover change for three time periods: 1987-1993, 1993-1999, and 1999-2004 was calculated
(iii) Land-cover-change probability was then analyzed by elevation and levee type to understand the vertical distribution of land-cover and change.



Land-Cover in 2004





Conclusions:

(i) Patterns of Farmland, Urban, and Wetland covers varied by elevation, by the relative likelihood of flooding within polders, and over time;
(ii) The general trend, with some notable exceptions, was toward less vulnerability of farmland and urban areas to flooding;
(iii) Factors of markets, laws and regulations have likely influenced changes in land-cover patterns and, therefore, in vulnerability.

An Analysis of Land Use and Vulnerability at Finer Scales using Household Surveys and Interviews

A Key Question:

WHAT factors (policies, biophysical environment and household characteristics) and HOW these factors affect land-use, and therefore, the vulnerability of a household through its land-use and livelihood decision making process?

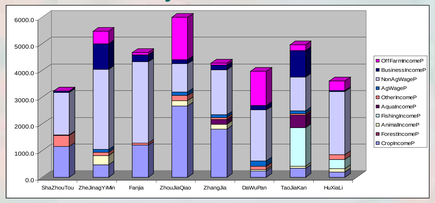
Approach:

Quantitative analysis using survey data & Qualitative analysis based on interviews

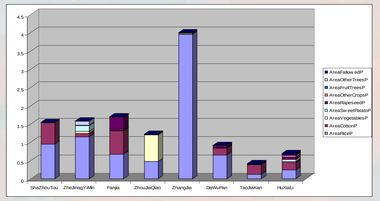
Surveys & Interviews:

Number of surveyed villages	8
Number of Households Surveyed	193
Number of Households Interviewed (with open-ended questions)	40+
Number of local government officials & scientists interviewed	10+

Income Diversity



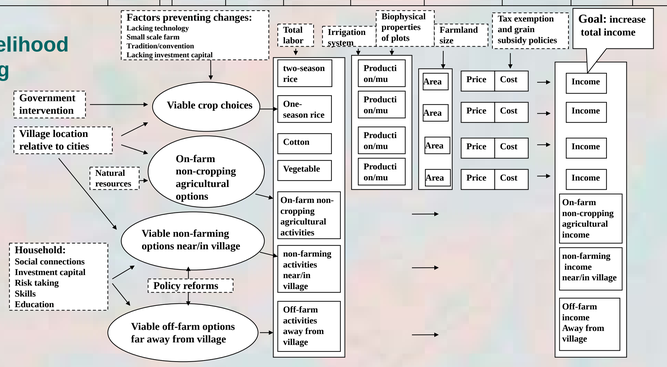
Crop Types



Multilevel Models for Cotton

	Variables	With No Variables		M1	M2.1	M2.2	M2.3	M2	M3.1	M3.2
					Add Household Variables				Add Irrigation Only	Add Location Variable Only
		Without Random Effects	With Random Effects	Add Plot Variables	Add Household Structure Variables	Add Land Resource Variables	Add Financial Variables	Add Social Connection &Education Variables		
Fixed Effects										
	Intercept	-0.81***	-0.71@	-0.82@	-0.78	-0.74	-0.68	-0.64	-0.60	-0.038
Plot Level	PlotSize			-0.59***	-0.57***	-0.63***	-0.64***	-0.64***	-0.64***	-0.64***
	Fertility			-0.02	0.01	-0.002	0.001	-0.005	-0.004	0.004
	Slope 2			0.31	0.33	0.32	0.35	0.35	0.35	0.35
	Distance			0.01@	0.01*	0.01*	0.01*	0.01*	0.01*	0.01*
Household Level — Household Structure	Household Type				-0.38	-0.45	-0.47	-0.47	-0.48	-0.51
	DependenceRatio				0.006	0.006	0.005	0.005	0.005	0.005
	PctFemaleLabor				0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	NumClgStudents				-0.51	-0.42	-0.48	-0.44	-0.44	-0.43
Household Level — Land Resources	TotalArea					0.05@	0.05*	0.05*	0.06	0.06*
	PctFlat					-0.001	0.001	0.001	0.001	0.001
	AvgPlotSize					0.004	-0.10	-0.11	-0.11	-0.12
Household Level — Financial Variables	HaveLoans 1						-0.08	-0.09	-0.09	-0.09
	SqrtOffFarmIncome						-0.002@	-0.002@	-0.002@	-0.002@
Household Level — Social Connection &Education	WithGovContact 1							0.004	0.003	-0.009
	Education 1							-0.06	-0.06	-0.05
Village Level	Irrigation 1								-0.13	
	CloseToCity 1									-0.88
Random Effects	Household Level			0.3095	0.2800	0.0913	0.0396	0.0272	0.0286	0.0261	0.0235
	Village Level			0.9959	1.0797	1.1188	1.1497	1.2456	1.2470	1.2396	1.1089
ROC		0.5		0.8008	0.8023	0.7840	0.7775	0.7779	0.7786	0.7783	0.7776

Land-use & Livelihood Decision Making



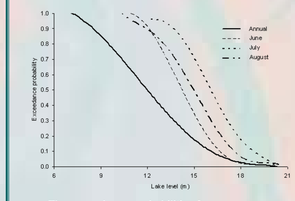
Conclusions:

(i) Policy reforms in China have reduced vulnerability by increasing incomes through other off-farm sources & reducing dependence on agriculture;
(ii) Households with different characteristics have different livelihood strategies and therefore different levels of vulnerability;
(iii) Most farmer households are currently limited in viable land-use and livelihood options, and future policies should aim to remove those constraints;
(iv) Flood risk does not affect farmer decision making, and they needed to be reminded about it.

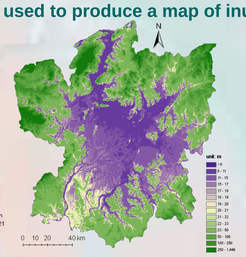
A Study of the Physical Environment: Inundation Extent and Flood Frequency Mapping

We combined Landsat TM/ETM+ images taken on different dates with two digital elevation models (DEMs) to model the extent of inundation around Poyang Lake.

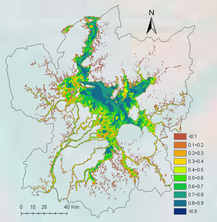
(i) Boundaries of the observed inundation extents were (a) labeled with simultaneous lake-level measurements taken at a representative hydrological station and (b) interpolated to create a digital water-body model (DWM);
(ii) The accuracies of spatial models of floodplain inundation based on a 30-m contour-based DEM, the 90-m SRTM DEM, and the 30-m DWM were then compared. The DEM results were reasonably accurate for high lake levels, with the contour-based DEM producing slightly better results than the SRTM DEM, but not for medium and low lake levels. The DWM exhibited improved accuracy at medium lake levels, but had relatively high errors at low lake levels;
(iii) The DWM-based model was used to produce a map of inundation frequency for characterizing flood risk.



The exceedence probabilities for every Duchang Lake level from 1970~2001 records



The digital water-body model (DWM) for PLR



Annual inundation probability for PLR

Household Land-use Strategies and Vulnerability: An Agent-based Land-use Model

Questions:

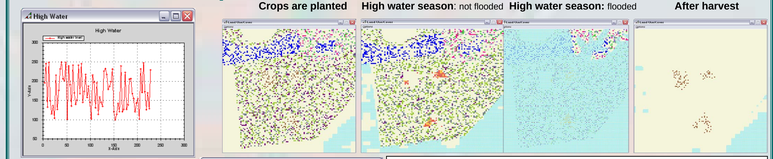
(i) Is it important to consider flooding risk in land-use?
(ii) How do different land-use strategies affect income & land use?

Land-use Strategies:

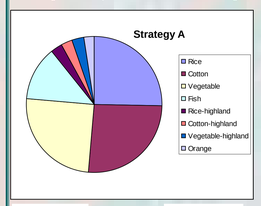
A. Maximizing income; B-D. Maximizing expected value:
EV = p*income $_{flooded}$+(1-p)*income $_{not\ flooded}$ (p is the probability that water comes in the polder)
B. using the probability of levee failure as an estimate of p
C. based on people's perceptions
D. according to a history of flooded plots

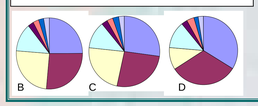
Model Run Examples:

Crops are planted | **High water season**: not flooded | **High water season:** flooded | **After harvest**

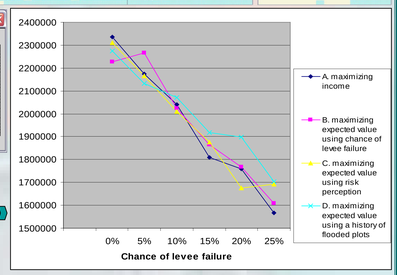


Resulting land-use patterns from different strategies





Total income vs. land-use strategies & levee construction



Findings:

(i) When the probability of levee failure is very small (< 5%), it may not be necessary to consider flood risk;
(ii) As the probability of levee failure becomes larger, maximizing income performs worse, and it becomes important to consider flood risk;
(iii) Using a history of flooded plots as an estimate of the probability of being flooded, performs better than other estimates.