AGRICULTURAL PERMANENCE IN LARGE ASIAN CITIES: A CASE STUDY OF NANJING, CHINA

GREGORY VEECK, CHARLES EMERSON AND ERIK S. BREIDINGER (M.S. 2019)[1],

[1]DEPARTMENT OF GEOGRAPHY, WESTERN MICHIGAN UNIVERSITY

ABSTRACT

Nanjing, the capital of China's Jiangsu Province, has grown rapidly during the post-reform era and the pace of change placed tremendous pressure on the city's arable land resources. This case study of land use/land cover change (LUC) in Nanjing's Jiangning district assesses changes in agricultural land, production, and labor within the ten 2016-era jiedao (sub-district political units) of Jiangning from 2000 to 2015. This case study provides an opportunity to assess an important component of the Ginsburg-McGee desakota hypothesis that predicts that Asian extended metropolis regions, unlike similar large cities in Western nations, will consistently maintain agricultural land and labor supplies within metropolitan boundaries. The study is based on two visits combined with time-series LUC analyses of a GIS database joining archived agricultural and agro-economic data with additional LUC data layers derived from satellite imagery including Landsat 8 Operational Land Imager (OLI) and Landsat 5 Thematic Mapper (TM) imagery. Results show Jiangning continues to retain high, if decreasing, proportions of agricultural land and employment. Jiedao in closest proximity to Nanjing's central business districts lost arable land at greater rates than those in the periphery. OLS linear multiple regression analyses identified factors that are the most effective predictors of arable land persistence including lower mean annual income, higher percentages of men in the workforce, a reliance on traditional double-cropped rice-wheat, and (inversely) to vegetables.

BACKGROUND: Changing Patterns for Urban Agriculture in China

Slightly higher in elevation than Nanjing proper, for elites, Jiangning District was a refuge from the heat and bustle of the city during both dynastic and Republican eras, particularly famous for horticultural products such as fruit, tea and honey, but also salted duck (板鸭). Most arable land was converted to grain production during the early years of New China, but particularly during and immediately after the Great Leap (1958-1961). After the start of the reform era, Jiangning farmers again quickly shifted away from grain-based double cropping systems (winter wheat –rice; rape- rice, winter barley-rice) in the mid-1980s to more of a desakota-characteristic mixed farm economy where a diverse agriculture sector evolved with manufacturing, tourism, new housing estates, and all types of services including agro-tourism . As Nanjing expanded, ultimately absorbing the county (now urban district), Jiangning was very effectively linked to the rest of the city, the nation and world through ambitious new transport networks including Lukou Airport (Nanjing's main airport), highways to neighboring Anhui and Zhejiang Provinces. Jiangning farmers responded by developing market oriented agricultural production systems that raised incomes while meeting demand for local-sources specialty and organic products. The low-cost transport and refrigerated warehouses have altered the crop mix produced in Jiangning as well as the markets where products are ultimately sold.

STUDY AREAS

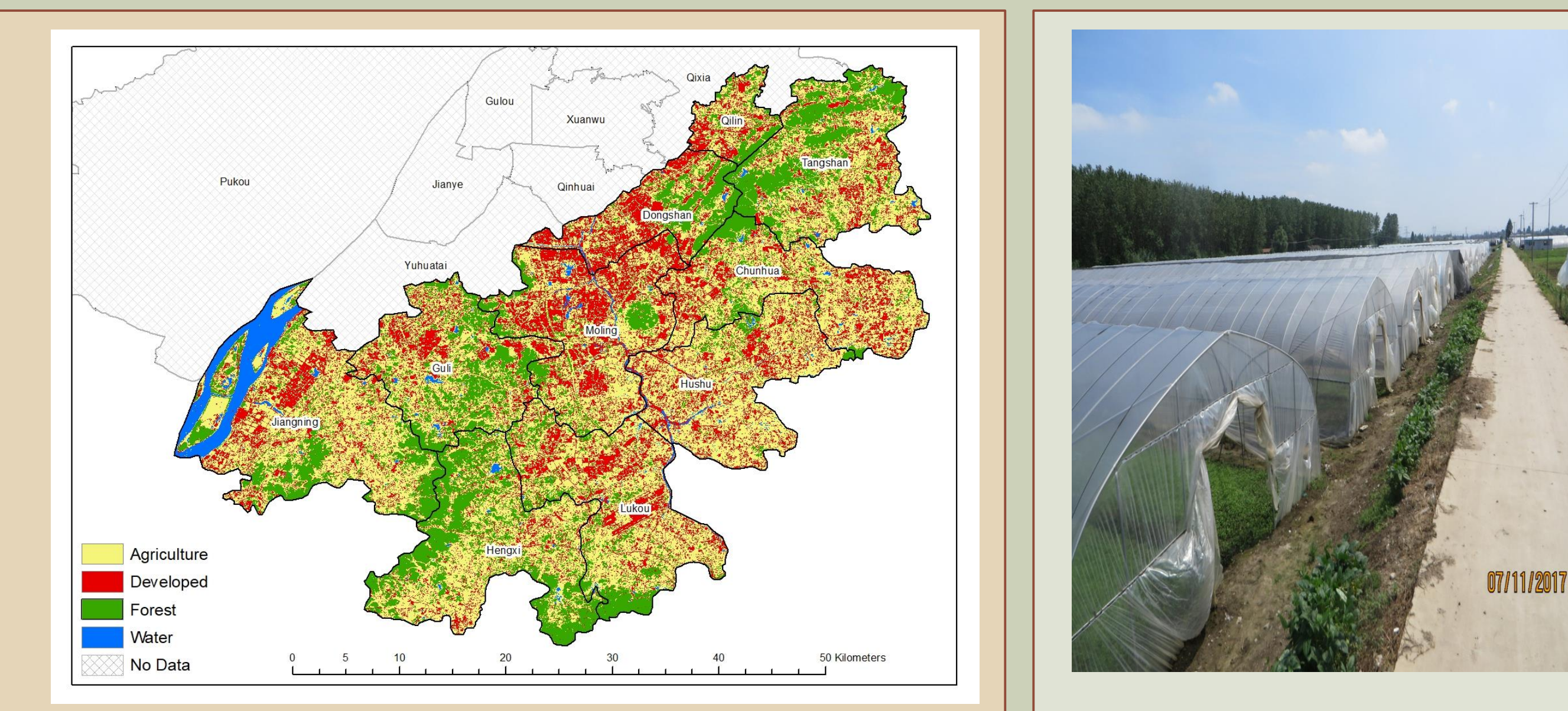## LOCATION OF THE RESEARCH IN Nanjing, Jiangsu in East China
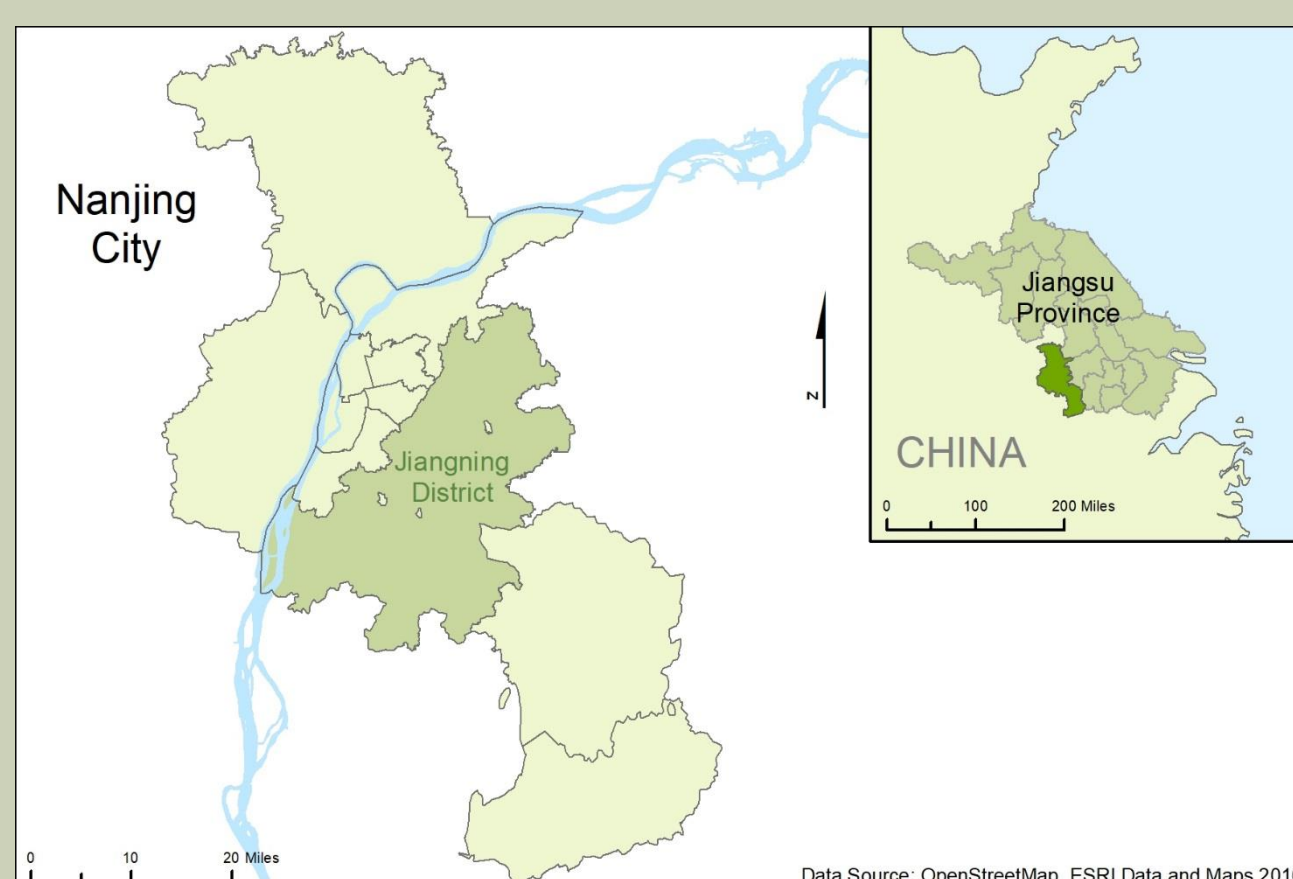
In May/June of 2017 and 2018, visits were made to a variety of agricultural areas under the political jurisdiction of the Municipality of Nanjing. Field work was conducted ultimately in Jiangning District with visits to over 70 farm fields. The research joins remotely-sensed environmental data and crop production data at the sub-district scale for the years from 2000-2015 to archived data and depth interviews with farmers, and urban planners.
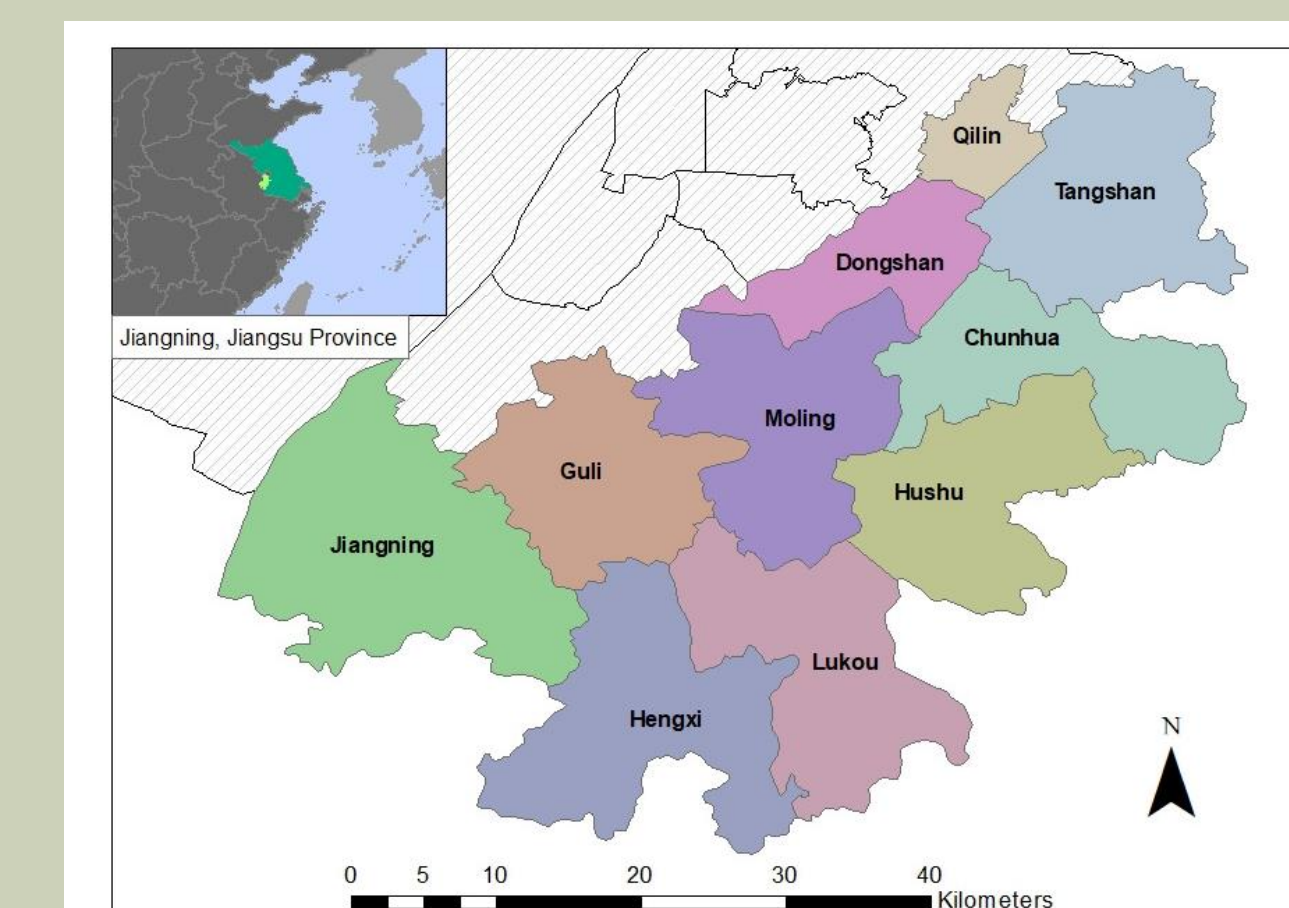
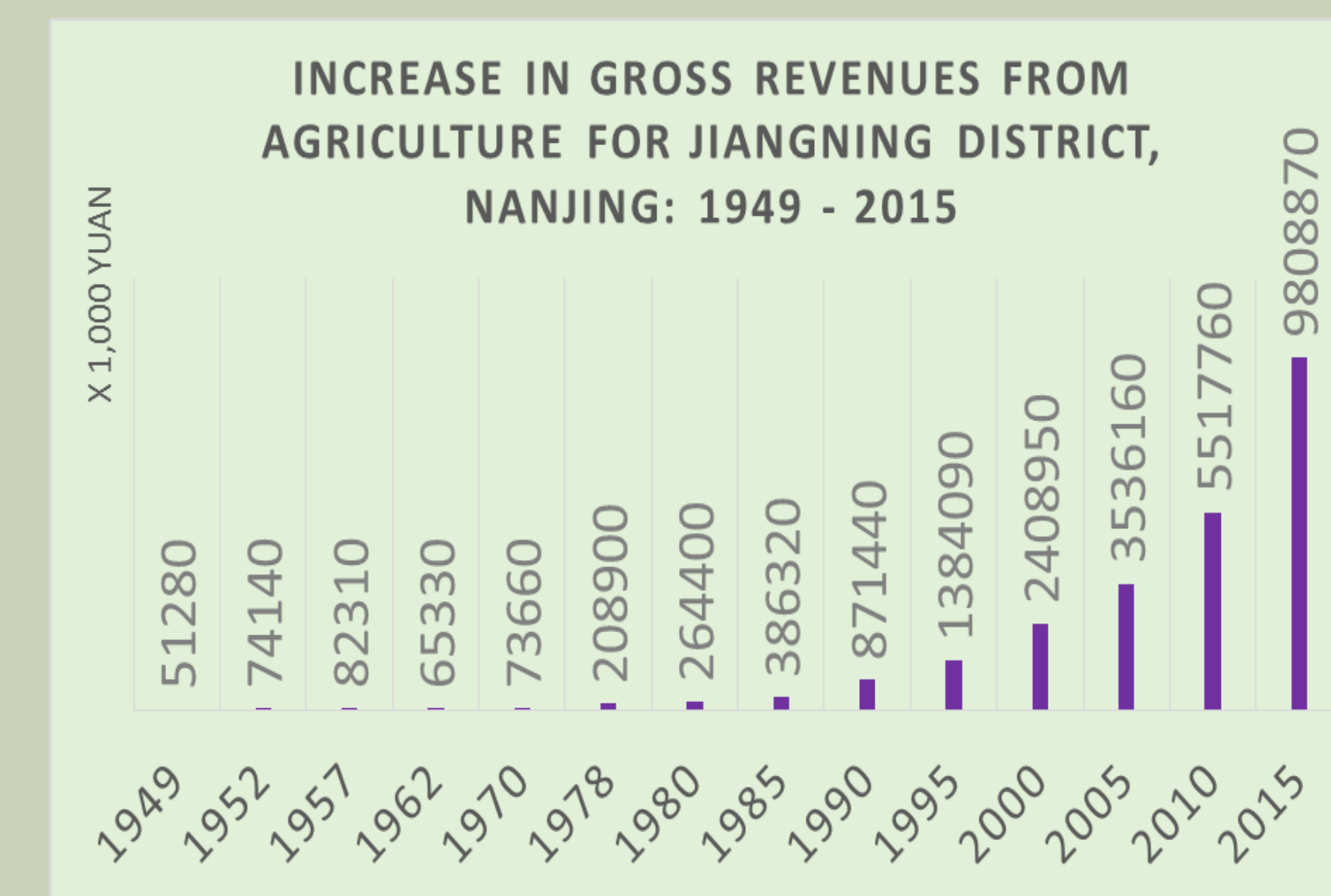## METHODOLOGY: A Mixed Methods Approach joining Remote Sensing, archived data and interviews

A mixed method approach is adopted for the research. Field visits incorporating discussions with experts on urban land use and planning at Nanjing University, interviews with farmers, and five day site visits to a diverse set of Jiangning farming areas were made during both July 2017 and May 2018. The fieldwork and interviews inform our interpretation of both archived agro-economic data derived from a number of sources, primarily the Jiangning Tongji Nianjian (Nanjing City Jiangning District Statistical Bureau 2001, 2011, 2015 2016) for the data years 2000, 2010, 2014 and 2015. We next compare agricultural land use change data from government sources with land cover maps were created using 30 m2 resolution Landsat imagery (Worldwide Reference System Path 120 Row 38) from dates within the May – October growing season contingent on minimal cloud cover so as to independently estimate agricultural land stocks for 2000 (Landsat 5), 2010 (Landsat 5) and 2015 (Landsat 8). Four land cover data layers for each of these three years (agricultural land, developed land, forested land and surface water) are derived from freely-available satellite imagery from the United States Geological Survey (https://earthexplorer.usgs.gov/) including Landsat 5 Thematic Mapper (TM) imagery and Landsat 8 Operational Land Imager (OLI). Each Landsat scene covers the entirety of Nanjing City, so to expedite data processing in the ENVITM image analysis application, a mask is applied so that only reflectance values for the ten jiedao within the Jiangning District are analyzed. For each jiedao (again, these are the sub-districts areas that serve as the units of our statistical analyses), absolute area and proportional estimates of arable land cover were derived from supervised maximum likelihood classifications for agricultural land cover supported with training data collected during field visits and cross-checked using data selected for multiple years from Google Earth Pro (https://www.google.com/earth/versions/). GIS arable land use maps (bottom) are created from the satellite imagery, then corrected for greenhouses with high albedo

RESULTS FROM Land Use/Land Cover Analysis

Low Separation of PCGs, villages, and agriculture

2-Meter Resolution

Closely-spaced mixture of agricultural and non-agricultural land is a key characteristic of desakotas

Agriculture
Developed
Forest
Water
No Data

Archived data confirmed our analysis of agricultural land use estimates for the ten "jiedao" or sub-districts of Jiangning District. We estimate that arable land declined from 77.7% of total area in 2000 to 49.9% in 2015, yet agricultural gross revenues increased 191-fold over the same period due to a decline in grain production and an increase in high value capital intensive fruits, vegetables, fish, crabs, and crayfish. Arable land loss was greatest in sub-districts closest to the built-up urban areas of Nanjing.

Declining arable land BUT increased net returns from crop sales

INCREASE IN GROSS REVENUES FROM AGRICULTURE FOR JIANGNING DISTRICT, NANJING: 1949 - 2015

X 1,000 YUAN

1949	51280
1952	74140
1957	82310
1962	65330
1970	73660
1978	208900
1980	264400
1985	386320
1990	871440
1995	1384090
2000	2408950
2005	3536160
2010	55117760
2015	9808870

A Strawberry "U-Pick" is a new feature with higher revenues

REASONS FOR RISING AGRICULTURAL REVENUES DESPITE DECLINING ARABLE LAND USE

As a result of the review of archived data for 2000, 2010 and 2015 related to various aspects of the farm sector in Jiangning, and the subsequent statistical analyses of these data and the remotely-sensed land use data for agriculture, several conclusions may be drawn. Firstly, at least in the case of the Jiangning District of Nanjing, defined as a classic desakota region by numerous scholars as noted, the agricultural sector will remain vital to the economy of Jiangning District of Nanjing, China. This is not to say, that the farms and farmers of Jiangning are somehow, static, unchanging while all changes around them. So secondly, we discovered a vibrant farm sector complete with new opportunities, and new products. Third, but related to the previous statement, it is certain that farming activities will take up less and less land over time as grain sown area declines and more valuable cash crops (tea, vegetables, fruit) are selected by farming families seeking more profitable substitutes for field crops, such as grains, soy, rape, or cotton. Statistical models (see article by same authors) are presented predicting the main criteria that support continued arable land use.

Testing agricultural land permanence and predictors of agricultural land use

N = 39 Panel data for 4 years (2000, 2010, 2014, 2015)

		Coefficients[a]			Adj. R^2 = .767	
Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	
1	(Constant)	-139.567	99.262		-1.396	.172
	PerCapRefmc	-.001	.000	-.312	-3.097	.004
	RiceArea	.000	.000	.184	1.899	.066
	New_Developed_area_%	-.670	.133	-.563	-5.049	.000
	Percent_Male	450.802	200.013	.212	2.254	.031
	VegProd	.000095	.000	-.202	-2.275	.029

a. Dependent Variable: New_AG_area_%

ABOVE: Farmer picking high value "Longjing" (dragon well) tea in areas once sown to rice and wheat double crop. RIGHT: turtle ponds

ACKNOWLEDGEMENTS