ERIA Discussion Paper Series

Impact of the 2011 Floods, and Flood Management in Thailand

NIPON POAPONSAKORN
Thailand Development Research Institute

PITSOM MEETHOM
Thailand Development Research Institute

November 2013

Abstract: *This paper first describes the causes of the major flooding in Thailand in 2011, which include natural events, unregulated land-use patterns and flood mismanagement. It discusses the government's quick response in drafting a flood management master plan and allocating USD 11,290 million for assistance and compensation for flood victims, restoration of damaged property, and implementation of the master plan. The weakness of the master plan is also pointed out.*

The study goes on to develop the "difference-in-difference" method to estimate the impact of the flooding on household income and expenditure in 26 flooded provinces. It matches the addresses of flooded households taken from the 2011 Socio-economic Survey, which did not have questions regarding the impact of floods, with the flooded areas from satellite radar images. Quantile regressions are employed to quantify the differential impact of the flood on households with different income levels. The results show that the flooding reduced total household expenditures by 5.7% to 14%. These findings are consistent with the reported negative national GDP growth of 8.9 % in the fourth quarter of 2011 when Thailand was flooded. One interesting finding is that the 2011 floods had a significantly negative impact on the income and expenditure of middle and high income households, but that its impact on poor households was not statistically significant. The study also finds that the 2011 floods had a negative impact on the money and wage incomes of some middle income households living in the flooded areas. All estimated coefficients in the business income regression are not statistically significant. Comparing farmers' income in the 2011 Socio-economic Survey with that in 2009, the study also finds that the 2011 flooding had a large negative impact on the farm profits of some middle income households in the flooded provinces.

Finally, the study discusses some policy implications, particularly weaknesses in the current information system for flood management.

***Keywords**:* Flood, flood management master plan, impact on household income, expenditures and farm profit, quantile regression, radar satellite images.

JEL classification: Q54, Q52, Q12, C21, O53

The 2011 flood was the worst flood in modern Thai history,[1] inundating 9.1 % of the total land area of the country, affecting more than 13 million people, with 680 deaths, causing total damage and loss of USD 46.5 billion, and paralyzing Bangkok and its vicinity for two months, which seriously affected investors' confidence. Damaged areas were dispersed in 69 provinces in every region of the country, with most damage and loss concentrated in the industrial estates and residential areas located in Bangkok, the adjacent provinces to the north and west of Bangkok, and the farm areas in some provinces in the Lower Northern region and Central Plains.

1. Rationale and Objectives

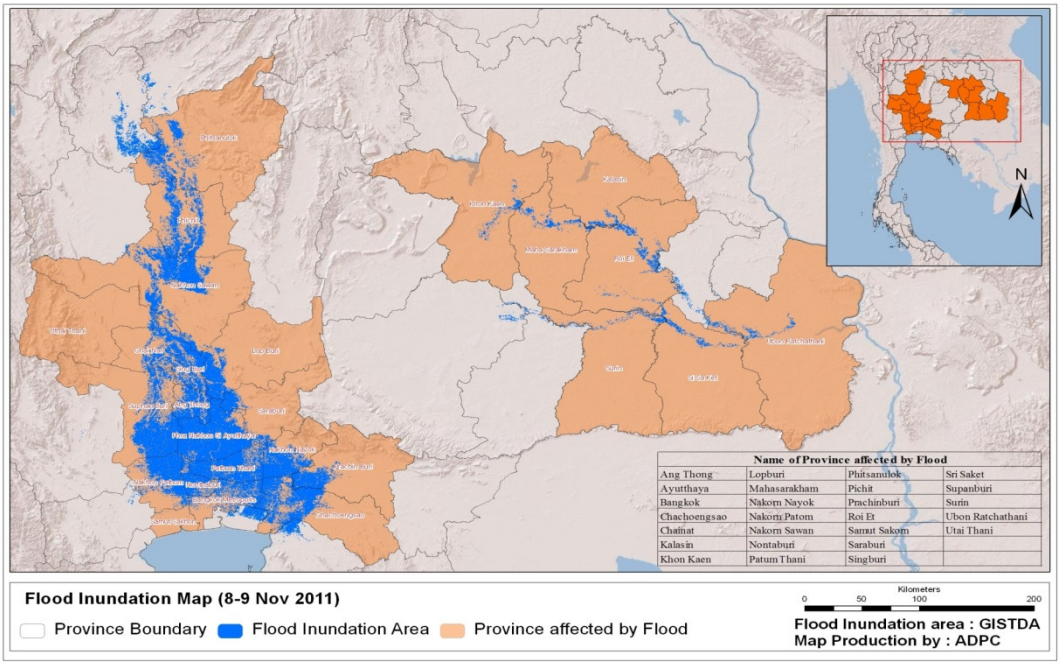
The government had been under political pressure to allocate 119.5 billion baht (or USD 3.85 billion) as assistance, restoration and compensation to the flood victims. However, the compensation depends heavily upon self-report by the victims, which tend to be exaggerated. The responsible bureaucrats have neither adequate resources (capability) nor incentive to assess the claims. In addition, since the estimate of output loss caused by the floods in the national income account is partly based on the loss and damage reported by the government agencies, it is useful to carry out an independent assessment of the impact of the flood on household income and loss in agricultural output, based on scientific evidence. Thus, interesting research questions are "what is the actual output loss?" and "are the compensation claims exaggerated?"

This paper is a partial attempt to revise the World Bank's estimates of agricultural output loss in November 2011, for several reasons. First, the WB estimates were done when the flood was yet to recede. Secondly, the flooded area was the only parameter determining the agricultural loss and damage at the provincial level, regardless of the duration of the flooding, let alone its severity. Thirdly, despite the availability of primary data on the impact of the flooding collected by some government agencies, particularly the satellite images secured by the Geo-informatics and Space Development Agency (GISTDA) and the Socio-economic Survey, there has been no attempt to utilize such data.

The objectives of this study are threefold. It will first describe briefly the causes of the 2011 flood and the policy response of the government. The second objective is

to revise the World Bank's estimates of agricultural loss.[2] Thirdly the study will estimate the impact of the flood on the expenditures and incomes of households in 26 flooded provinces (see Figure 1) in comparison with those of households in the non-flooded areas. Finally, some policy implications will be drawn.

Figure 1: Map of Flood Inundated Areas, 8-9 November 2011



Source: The World Bank (2012). Original source of satellite image is GISTDA.

2. The 2011 Thailand Flood: Causes and Policy Response

The 2011 flood affected 69 provinces with the total flood inundation area of 41,381.8 square km (GISTDA). Of these, 19 provinces were most severely inundated, located in the Chao Phraya and Tha-Jeen River basin, including Bangkok and surrounding provinces. Flooding began around late July 2011, and receded in mid-December 2011.

Facts Relating to the 2011 Thailand Floods

Given the higher altitudes of the Northern provinces, the surface water from the Northern provinces flows south to the sea through a few major rivers in the three major river basins in the Lower North and the Central Plains, i.e., the Chao Phraya River, the Tha-Jeen River and the Pasak River basins. Once the floods over-flowed the river banks in the Central Plains, they moved only very slowly, i.e., 2-3 km per

day, thanks to the "flat" land. Farmers who live along the rivers or in the flooding areas near the rivers have been used to and well adapted to the annual flood. Thus, unlike in a flash flood, losses were greater than damage to property and life, because people had plenty of time to prepare and evacuate. In addition, since Bangkok's sewage and canal systems are designed for the drainage of rain water and not for flood discharge, most flood water had to be diverted either to the east or the west of Bangkok. Without this diversion loss and damages would have been astronomical, and would have led to loss of confidence in Thailand's management capability.

Impact of 2011 Flood: Loss and Damages

The 2011 flood affected 12.8 million people, caused 728 deaths, and damaged 10.417 million rais (16,668.55 square km) of agricultural area (Ministry of Agriculture 2012) and 9,859 factories. It also affected 660,000 jobs as of 25 November 2011.

Overall, the total damage and loss amounted to THB1.43 trillion (USD 46.5 billion), with losses accounting for 56 % of the total (Table 1). The World Bank estimates that recovery and reconstruction would cost THB1.49 trillion (USD 50 billion) over the next 6 months and beyond.

Table 1: Damages and Losses by Sector (mil USD)

Sub Sector	Disaster Effects			Ownership	
	Damage	Losses	Total	Public	Private
Infrastructure					
Water resources management	284	-	284	284	-
Transport	768	226	995	990	5
Telecommunication	42	83	126	52	73
Electricity	104	187	291	176	115
Water supply and sanitation	114	65	179	179	-
Cultural heritage	145	100	245	99	146
Productive					
Agriculture, livestock and fishery	185	1,133	1,318	-	1,318
Manufacturing	16,773	16,100	32,874	-	32,874
Tourism	168	2,927	3,095	13	3,081
Finance & banking	-	3,763	3,763	2,418	1,345
Social					
Health	55	70	125	53	71
Social	-	-	-	-	-
Education	426	59	485	346	138

Housing	1,498	1,237	2,735	-	2,735
Cross Cutting					
Environment	12	6	18	7	11
TOTAL	20,575	25,956	46,531	4,618	41,913

Source: World Bank, 2012 . Note Exchange rate is 30.6366 Baht/USD.

Factors Causing the 2011 Floods: from Mother Nature to Man-made Mistakes

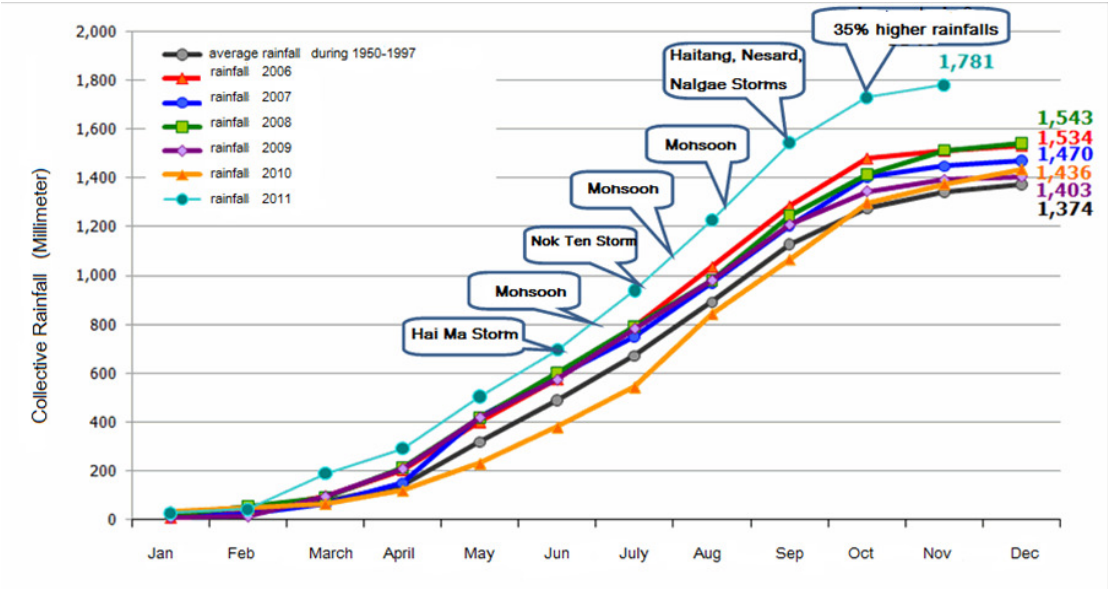
There were four major factors causing the 2011 floods (Suppaisarn 2011). These were 1) the highest recorded rainfall together with five consecutive tropical storms in the mid rainy seasons, which in turn, caused 2) water runoff from the major rivers, 3) unsuitable land use in the flood plains, and 4) flood mismanagement.

Factor 1: The average rainfall of 1,781 millimeters between January and October 2011 was the highest on record, and was 35 % higher than the 50-year average (Figure 2). Moreover, 5 tropical storms, which happened consecutively between the end of June and the beginning of October (Figure 2), contributed to heavy rain in the mountains to the North and in the Central regions. "The total rain for July to September was 1,156 mm – the highest amount of rain recorded since record keeping began in 1901. The probability of such a rain event has been estimated at 1 in 250 years" (World Bank 2012:77). The storms also caused flash floods in several Northern and Northeastern provinces in the early rainy season and raised the water levels in the major dams to their maximum capacity (Suppaisarn 2011):

- Haima Depression (from 23-27 June, 2011): rainfall 5 days > 150 mm.
- Nok Ten Depression (from 30 July-1 Aug, 2011): rainfall 3 days > 150 mm.
- Hai Tang Storm (from 26-28 Sep, 2011): rainfall 3 days > 180 mm.
- Nesard Storm (from 2-3 Oct, 2011): rainfall 2 days >120 mm.
- Nalkae Storm (from 6-7 Oct, 2011): rainfall 2 days >100 mm.

The high density of rain between July and September generated an unprecedented flood peak in the Chao Phraya river at the tide station in Nakorn Sawan province (C2) of 4,686 cubic meters per second (cms) against the maximum channel capacity of 3,500 cms (see Figure 2).

Figure 2: Average Cumulative Annual Rainfall – 1960-2011



Source: Thailand Integrated Water Resources Management. (www.thaiwater.net)

Factor 2: Water runoff from major rivers exceeded the capacity of the rivers. Both heavy rainfalls in the North and the Northeast and water discharged from major dams exceeded the capacity of the rivers, overflowed the riverbanks, and inundated vast flood plains. The World Bank (2012: 78) argues that "A major difference between this flood and other severe flood events was that water levels rose at a slow, steady rate, and flood water persisted in some areas for almost 70 days before receding. The main cause of the flooding was the low flow capacity of the river, which resulted in river dykes overtopping and breaching in many river arms. Also the river's capacity decreased downstream, which implies that spillage from the river channel gradually occurs in the upstream areas when a large-scale flood occurs". Though some questions were raised regarding the operation of the major reservoirs (more below), the Bank argues that "there was simply much more water upstream than the downstream channel was able (to) manage".

It should be noted that water runoff in the Lower North and the Central Plains did not exceed the channel capacity (3,500 cubic meters per second (cms) at Nakorn Sawan tide station (C2), and 2,500 cms in Chainart) until September. One reason is that water outflows from the two Northern dams, i.e., the Bhumibol and the Sirikit dams, were much less than the water inflows into the dams between June and September. This controversial issue of flood mismanagement will be discussed below.

Floods in Bangkok and surrounding provinces, therefore, were caused by a combination of four factors, i.e., high discharges from the upstream Chao Phraya River, releases from the mainstream reservoirs, high sea levels in the Gulf of Thailand and high intensity rainy in the city, exceeding the drainage network (World Bank 2012).

Factor 3: Rapid (and unplanned) urbanization and unsuitable land use in the flood plain areas is probably one of the most important factors worsening the floods. For example, industrial and housing estates were located in the areas which were supposed to be the flood plains, thanks to the mistake of industrial promotion policy in the 1980s and other reasons discussed below; and many infrastructural facilities also block the canals and rivers, etc.

Except in Bangkok, there has been no implementation of land use zoning in most provinces. In Ayuthaya province, several industrial estates and housing developments were allowed to locate in the flood prone areas, just because the land prices were the lowest[3]. Since the estates blocked the flood ways, it is not surprising that they were severely inundated for months. In Bangkok where there has been land use zoning, the zoning law has been changed by politicians to serve the interests of business and property developers. The most obvious example is the lobby to convert the eastern areas of Bangkok, which were designated as flood ways, to residential areas. To make things worse, the government is also the main culprit as it decided to build the new Suvarnabhumi airport in the flood plains of eastern Bangkok. Flood plains and canals were also blocked by both public and private infrastructure and urban sprawl. Many public canals simply disappeared because of illegal encroachment. Such changes in land use took away the ability to drain water from the northern part of Bangkok into the canals and drainage systems, and then to the drainage stations by the sea coast of the city.

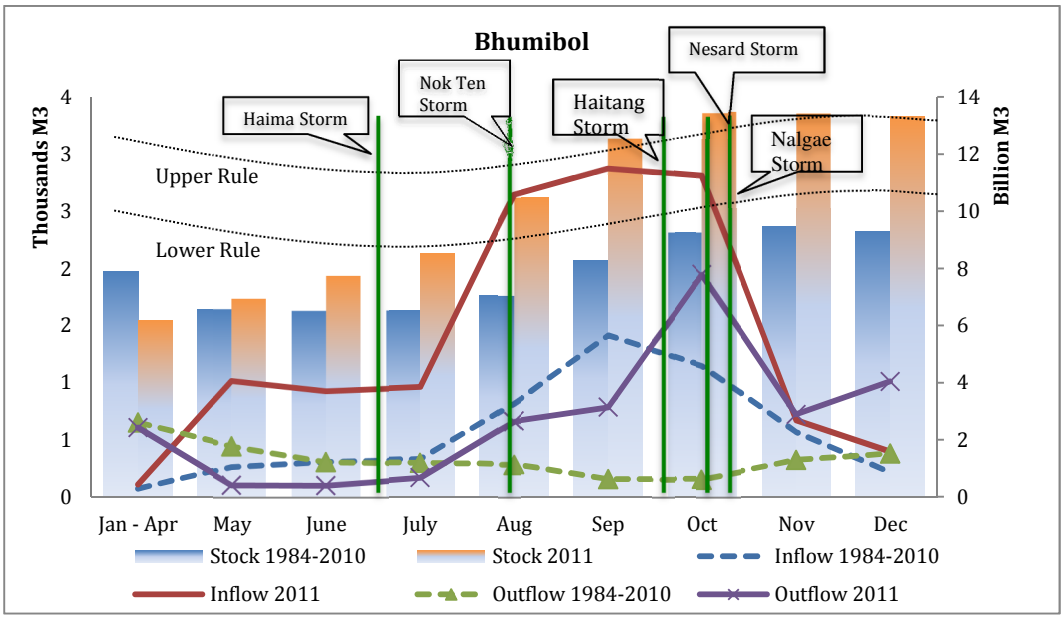
Factor 4: The floods were worsened by man-made mistakes, particularly political intervention and mismanagement. Flood mismanagement includes (a) the weakness of existing operations of major reservoirs, (b) political intervention in dam operation and irrigation management, (c) ageing structures and deferred essential maintenance of the irrigation and flood protection infrastructure, which was the primary reason for structural failure and breaches of the flood protection embankment along the Chao Phraya River[4], and (d) lack of an effective flood forecasting and early warning system, and (e) the emergency mismanagement, e.g., the mis-handling of refugee

centers for flood victims and flood relief management. We will discuss only four of these problems.

a) *The weakness of the existing operations of major reservoirs.* This involves the validity of current estimates for extreme floods together with the ambiguous instructions for the operation of the spillway crest gates at major dams. For example, the inflexible and probably out of date "Rule Curve"[5] results from lack of information on seasonal weather forecasts, out-dated flood hydrology evaluations and routing (or a process of selecting paths) of the probable maximum flood (PMF), and a one-in-10,000 year flood (World Bank 2012: A-36), and inadequate information on changes in cropping patterns which affect the detailed gate operation schedule. In addition, the small height difference between normal water level and maximum water level (narrow Rule curves) at several major dams means that there is little time for the dam operators to deliberate and seek approval from higher authority when they need to quickly change the schedule of gate opening in response to an emergency.

It is claimed that there were political pressures on the dam operators to delay opening the gates, in order to avoid flooding downstream and to conserve maximum water for the dry season crops, as well as financial incentives for the Electricity Generating Authority of Thailand (EGAT) to deliberately keep stock water in Bhumibol and Sirikit Dams at high levels since the second quarter of 2011 in order to gain higher revenue from the lower cost of electricity generation. In response, EGAT stated that their measures of water management, including discharging water from the dams, were taken in accordance with the Rule Curves of the dams. It also declared that EGAT could not profit from ROIC by retaining more water in dams, given the method of fuel tariff (FT) charges.

Figure 3: Monthly Water Inflow, Outflow, and Stock at Bhumibol Dam, 1984-2011



Source: EGAT

According to Figure 3, in spite of the exceptionally high water inflow into the Bhumibol Dam between July and September 2011, which was higher than the average water inflow between 1984-2010, the rate of water outflow was lower than the inflow. From mid-September until November, the water inflow to the dam surged rapidly due to the effects of the Haitang, Nesard, and Nalgae storms. The water level quickly reached the dam's capacity. The exceptionally high rate of water outflow therefore had to be drained through the Ping River. Sirikit Dam's water inflow and outflow showed a similar trend. Water discharged from these two dams significantly increased the water level in the Ping and Nan rivers , which then flowed downstream to the Central Region, aggravating the flood there.

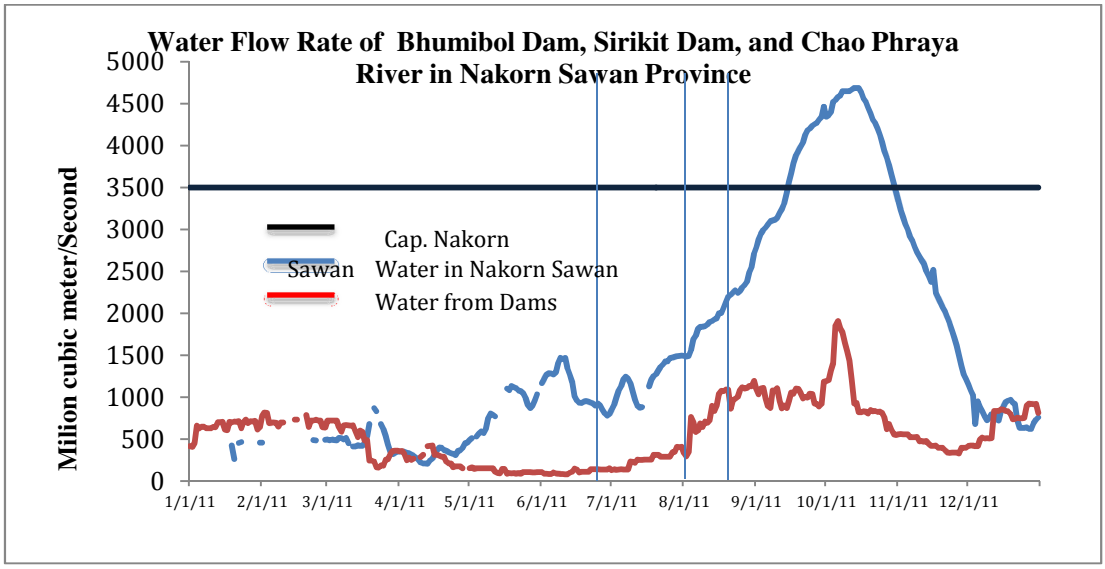
There are 3 main causes that may have contributed to the flood mismanagement.

- The dependence on rigid and out-of-dated Rule Curves may have caused the water discharge measure to be unfit for the extreme weather conditions, particularly in the case of the 2011 flood, according to some engineers. In addition to the bureaucrats' inadequate attention to the weather conditions and the exceptionally high water inflows in the major dams, the government does not yet have adequate capability in seasonal weather forecasting (i.e., the weather forecast for 3-4 months), and does not yet have catchment-based flow forecasting systems. Given the modern technology of seasonal weather forecasting and the increasing incidence of extreme weather, it has been recommended that the government

commission a study on the modernization of dam management (World Bank, 2012).

- EGAT argued that the water outflows from the two major dams were not the major factor contributing to the flood in the Central Plains since they accounted for only 16-17 % of total surface water flowing from the dams, and other Northern rivers, (which do not have large reservoirs, i.e., the Wang and Yom rivers) that flowed through Nakorn Sawan province (Figure 4). But this may lead to the conclusion that when EGAT made decisions to discharge water from the dams, they ought seriously to have taken into account the volumes of rain water that would have overflowed from all four Northern rivers between August and September. By doing so they would have made better decisions relating to the discharge of more water from the two Northern dams between July and September.
- Finally, although EGAT cannot charge a higher tariff for its electricity, the lower cost of electricity generation when the water stock in the dams is at peak level will result in higher net revenue for EGAT and, hence, higher bonuses for its employees.

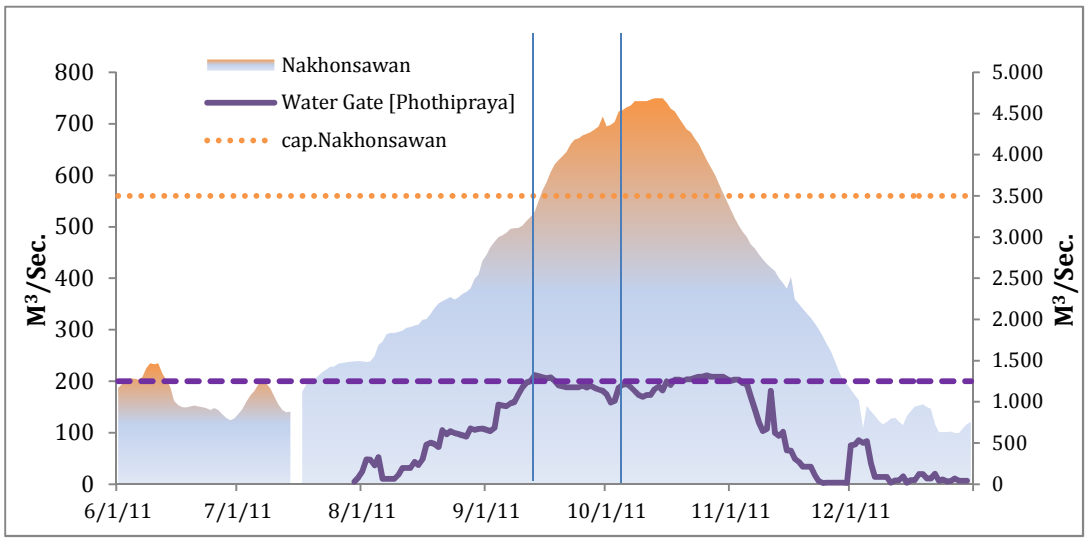
Figure 4: Water Flowing through Nakorn Sawan Province



Source: RID.

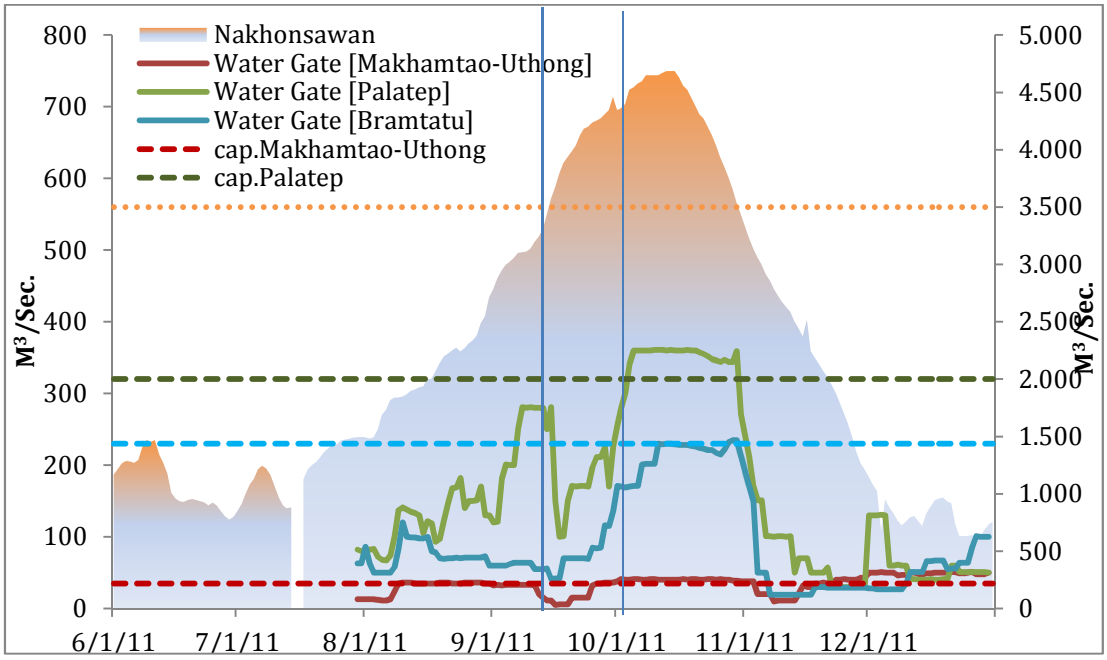
b) Political influences. When the water from the four Northern rivers, reaches Nakorn Sawan, a Lower Northern province where the four rivers merge and form the Chao Phraya river, it can be diverted by the Chainart barrage into five major natural or artificial channels, three on the west bank (i.e., Makhamtao-Uthong canal, the Supan and Noi rivers), and two on the east bank (Chainart-Ayuthaya and Chainart-Pasak Canals). There is a criterion that all the sluice gates will open on August 15. But there was one newspaper report that some politicians might have influenced the decision to control the sluice gates, and to delay the water discharge into the western province for 15 days, to allow the farmers in their constituency to harvest their rice crop. Figure 5 shows the diversion of water through the sluice gates in the eastern side of the Chao Phraya River, compared to the amount of water flowing through Nakorn Sawan. Figure 6 compares the flows of water through the western gates with the amount of water flowing through Nakorn Sawan.

Figure 5: Water Flowing through Chao Phraya River in Nakorn Sawan and Phothipraya Gate on the East Side of the River



Source: RID

Figure 6: Water Flowing through Gates on the Western Side of Chao Phraya River and Chao Phraya River in Nakorn Sawan



Source: RID

According to Figure 4, water in Nakorn Sawan started to rise above its capacity in mid-September. It also shows that the Phothipraya sluice gate started to open to its maximum capacity at the same time, and remained open at a very high level until November.

Yet, according to Figure 6, the three sluice gates in the western side of the Chao Phraya river were not open to their maximum capacity until the beginning of October. Compared to the Phothipraya sluice gate in the east, the Pollathep, and Baromathad sluice gates in the west were only opened at their maximum capacity when it was too late, during October and November. Water was not allowed to flow through the Makhamtao gate at maximum capacity for a week in September so that farmers in Supanburi had time to harvest their paddy.[6] Most water, therefore, had to flow down the Chao Phraya river or was diverted to the east. If the sluice gates had been opened wider and earlier, water could have flowed to Derm-Bang Nangboach, Sri Prajan, Donjadee and Muang districts in Suphanburi Province, which have at least 500,000 rais of flood plain area to retain water. The result of these sluice gates' water mis-management, together with the deferred essential maintenance of the sluice gate at Bang Chomsri was that water inundated 402,164 rais of agricultural land in Lopburi,

particularly in Ban Mi and Tha Wung districts, and other districts in Chainart and Sing Buri (Bangkokbiznews, 2011).

One reason the floods in Ayuthaya and Bangkok were more serious than they should be is that water was blocked from flowing into the Raphibhat canal for three weeks, according to water experts. The canal is the key channel to divert excess water to the east of Bangkok where there are flood way, canal network and large pumping capacity to bring water to the sea.

c) *Ageing structures and deferred maintenance of flood protection and irrigation facilities.* There were at least 13 sluice gates that were damaged in the 2011 flood. Three of them collapsed causing major flooding in some areas. The damage was not only caused by the major flood but also by the lack of proper maintenance of the flood protection infrastructure.

d) *Emergency mismanagement.* Here are some reported cases of emergency mismanagement of the 2011 flood.

-The slow response to the Bang Chom Sri sluice gate's collapse caused too much water to flow into Lopburi province, which then flowed back to Ayuthaya district via the Lopburi river. Not only was there a slow response, but the repair of the Bang Chom Sri sluice gate was left to the resource-poor local government instead of being undertaken professional central authorities.

-The Prempracha and Ladprao canals, which are drainage channels, have been illegally occupied by hundreds of slum dwellers. Both channels are now half of their previous sizes.

-There was a claim that the authorities in charge made a grave mistake by diverting a large flow of water to the west of Bangkok and then to the Tha-Jeen river, which does not have the facilities to manage the water runoffs. This measure had never been taken in the past and proved to be ineffective since the Tha-Jeen river is winding and not suitable to divert water to (Tobunmee, 2012). There were several instances where local politics overrode the central government (FROC) authority in flood management and flood relief activities. For example, some local politicians led the people who were affected by flooding to destroy the flood protection dykes or to pry open the sluice gates so that water could be diverted to other areas. Such action was for local interest at the expense of the wider public benefit. On the other hand, there were also conflicts between people in communities that were outside the flood barriers which were used to protect people in another province. For instance, the locals of Chainart protested against the Minister of Agriculture and Cooperatives, and accused him of favoring Supanburi by blocking the flood water from entering into Supanburi, thus inundating Chainart. Ultimately, they, by force,

removed 3 levels of sandbags that were placed across the Pollathep waterway to let water flow to Supanburi (Thairath online, 2011).

-There were serious coordination problems between the central government and the local government administration, especially Bangkok Metropolitan Authority (Komchadluek online, 2011), thanks to the fact that they belong to different political parties.

How did Thailand Handle the Flood?

a) Flood Management during the Crisis

The Thai Government established a Flood Relief Operation Center (FROC) in October, 2011. FROC's central office was located in Don Muang district of Bangkok. It served as the migrant center and shelter for flood victims. It also functioned with assistance from the military to repair irrigation facilities, evacuated flood victims from flooded areas, delivered survivor kits, etc. About USD 17.89 million were spent for flood relief activities. Unfortunately, the FROC office in Don Muang district was later heavily flooded, and was forced to relocate.

b) Flood Management Master Plan

Right after the flood, the government set up two committees to draft a flood management master plan, which was finished in a few months. The plan has 3 objectives:

1. to prevent, mitigate and reduce the damage caused by flooding
2. to improve the efficiency of the flood prevention and the emergency flood management systems
3. to build public confidence and security, to increase national income and to manage natural resources on a sustainable basis.

The master plan is based upon two approaches, i.e., the structural (or physical infrastructural) measures and non-structural measures based upon the Royal Initiative (which was first publicly disseminated in 1983).

The structural approach to flood management includes measures to "store and divert" water. One clear option is to increase the number and capacities of water reservoirs. At present Thailand has about 1,000 cubic meters of water storage capacity per inhabitant compared to the US, which has over 5,000 cubic meters (World Bank 2012:81). Another flood protection structure is the construction of floodways to divert water. The government will rely upon a Japan International Cooperation Agency (JICA) study which will make recommendations on

infrastructural investment and flood management for both short-term and long-term solutions.

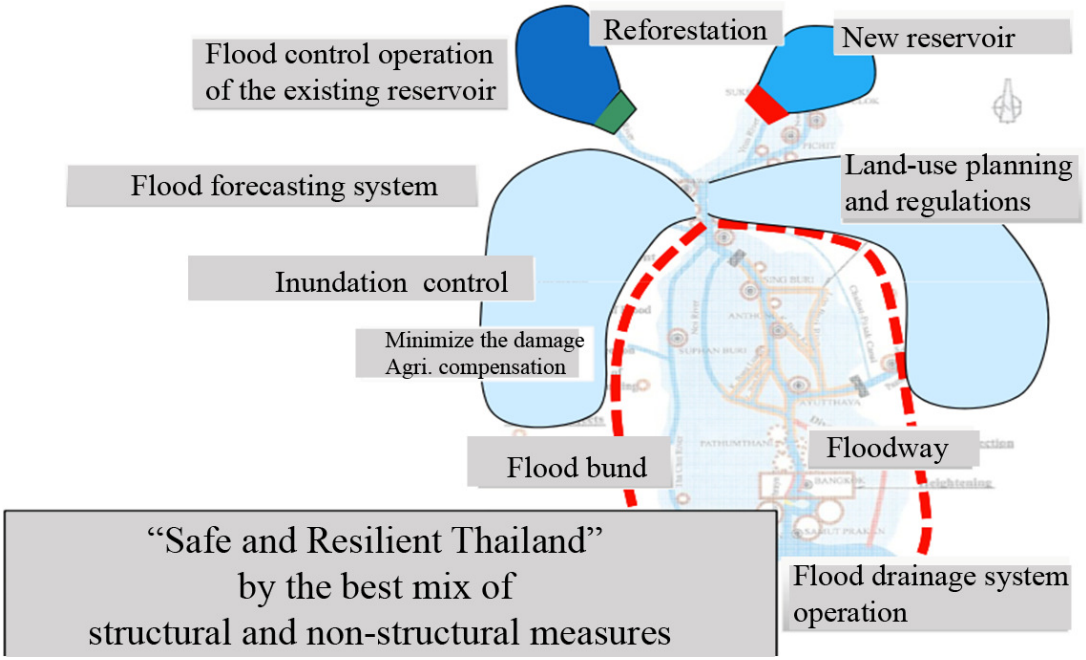
The non-structural Royal Initiative is to create "room for the river", which would allow for increased areas for floods to spread. Reforestation is also part of the Initiative to prevent rapid flooding in the upstream river basins. The concept of "room for the river" consists of the large flood retention areas and Monkey Cheek[7] reservoirs (the so-called *"Gamling"*). A study of the potential flood retention areas in Bang Ban sub-district in province finds that the Bang Ban area has a potential to be developed into a reservoir for the following reasons (Suppaisarn, *et al.* 2008):

- It is easy to divert water excess to designated reservoir areas with flood barriers surrounded the area
- There is a protection plan for residential houses, industrial sections, and agriculture areas, i.e., designating areas for collective residential housing and building barriers for houses and farmlands along the waterways.
- Bang Ban has drainage channels, natural water trails, and spaces that can be converted into flood division channels, if needed. It also has a water-controlling station, which consists of a sluice gate, drainage channels, and a water-pumping station.
- Water can be drained from Bang Ban when water levels in areas outside the reservoir decrease by closing the sluice gate and pumping water out.

The "Monkey Cheek" concept is also useful, as His Majesty the King Bhumibol Adulyadej stated in 2003 that, "...Monkey Cheek reservoirs are needed in order to retain water when the sea water rises and water excess cannot be drained. During the flooding season between September and November, the seawater will push water in rivers until it reaches Ayuthaya province, which will make it impossible to drain excessive rain water into the sea. As a result, the areas along the Chao Phraya river in the lower Central Plains will remain flooded.Therefore, we need Monkey Cheek reservoirs" to receive water excess during the flooding season (Suppaisarn, 2011).

Figure 7 presents the overall framework of the flood water management as envisaged by the JIAC study.

Figure 7: The Best Mix of Structural and Non-structural Measures



Source: Takeya Kimio, " JICA's Support 'Toward Safe & Resilient Thailand' through revising the Comprehensive Flood Management Plan for the Chao Phraya River Basin". 20 February 2012.

The water management master plan consists of 8 work plans, and implements guidelines as follows (from *"Master Plan on Water Resource Management"* by the Office of the Strategic Committee for Water Resource Management (SCWRM), and the Office of the National Economic and Social Development Board in January 2012):

(1) *Work Plan for Restoration and Conservation of Forest and Ecosystem*: aiming to restore watershed forest where water is retained, to develop additional water reservoirs according to the capacity of the areas and to develop land usage plans that fit with their local and socio-geographical conditions by restoring and conserving the degraded watershed areas, developing projects for soil and water conservation by promoting economic and community afforestation while rehabilitating mangrove forest, improving water and land usage, increasing storage capacity, and revising and drafting relevant laws.

(2) *Work Plan for Management of Major Water Reservoirs and Formulation of the National Annual Water Management Plan*: aiming to prevent and alleviate the impacts of possible floods in the future by developing water management plans for major dams and river basins, formulating water management plans under different scenarios, improving the Rule Curves in water management to balance water use

in several sectors, and presenting water related information to the public.

(3) Work Plan for Restoration and Efficiency Improvement of Current and Planned Physical Structures: aiming to prevent and mitigate the impact of flooding by implementing 4 sub-work plans including (1) renovating dikes, water control buildings, and water drainage systems to ensure effectiveness in every area, (2) improving drainage water-ways, dredging canals, removing barriers in canals and draining water-ways, (3) increasing efficiency in management of water drainage and overflows in specific areas, and (4) reinforcing dikes and following the King's initiatives. In the long term, several measures will be implemented, including the construction of flood-ways or water diversion channels, and preventive dikes for key economic areas, as well as land use planning.

(4) *Work Plan for Information Warehouse as well as Forecasting and Disaster Warning System:* aiming at developing data systems, creating hypothetical scenarios based on technical principles, setting up water management institutions, and increasing efficiency in the warning system by (1) setting up a national water information center, (2) constructing hypothetical water scenarios, forecasting and disaster warning systems, (3) enhancing the national disaster warning system to become capable of monitoring and analyzing the water situation in a timely manner by improving and increasing the number of water monitoring stations in major rivers, installing CCTVs at the water gates and pumping stations, upgrading satellite and remote sensing systems, and reorganizing and developing disaster warning systems.

(5) *Work Plan for Preparedness for Emergency Situations in Specific Areas*: aiming to build capacity in prevention and mitigation of impacts from floods by developing the systems of flood prevention and mitigation in the important areas such as agriculture, industry, and dense communities, creating a system for negotiating between the affected parties, constructing warehouses for tools, and assessing the impacts of private prevention systems.

(6)*Work Plan for Assigning Water Retention Areas and Recovery Measures*: by assigning water retention areas in the upper and lower Chao Phraya River basins, developing the water retention areas to slow down water flow during flash floods, formulating a plan for diverting water into water retention areas whilst creating measures for special compensation to those areas assigned to be water retention areas.

(7)*Work Plan for Improving Water Management Institutions*: aiming at setting up integrated water management organizations, as a single command authority that can make prompt decisions during a crisis and

is responsible for planning, monitoring and evaluation, revising rules and regulations. For the urgency period, this single command authority is the Ad Hoc Committee chaired by the Prime Minister or the assigned Deputy Prime Minister and comprises ministers and permanent secretaries of related ministries as members. In the long term, a national integrated water management agency should be set up permanently.

(8) *Work Plan for Creating Understanding, Acceptance, and Participation in Large Scale Flood Management from all Stakeholders*: Government and development partners would call for collaboration with community and people in managing the impacts of floods and other major disasters.

c) Flood Action Plan and Budget

The action plan budget consists of an immediate flood compensation budget and a budget for the flood action plans.

(1) *Assistance, restoration, and compensation budget:* The government allocatedUSD 3,902 million of the central budget (~USD 1,534 in FY 2011, and ~USD 2,383 in FY 2012) to provide assistance, restoration, and compensation to flood victims.

From October 2011 to May 2012, state agencies have already spent 79,750 million baht from these budgets through related projects/work plans.

(2) Flood action plan, including 2 related action Plans: an action plan for water management for the emergency period and an action plan for integrated and sustainable flood mitigation in the Chao Phraya river basin:

(2.1) Action plan for water management for the emergency period. Its key principle is to reduce losses and damage due to flooding, and to minimize its economic and social impacts. There are 6 main work plans with a total budget of 18,110 million baht (see details in the Flood Management Master Plan 2012)

(2.2) Integrated and sustainable flood management action plan. This comprises 8 work plans with a budget of 300,000 million baht. The government has already passed a law enabling it to borrow 300,000 million baht.

- Work plan for restoration and conservation of forest and ecosystem
- Work plan for management of major water reservoirs and formulation of water management

- Work plan for restoration and efficiency improvement of current and planned physical structures
- Work plan for information warehouse and forecasting and disaster warning system
- Work plan for response to specific area aims at building the capacity in prevention and mitigation of impacts from flood by developing the systems of flood prevention and mitigation in the important areas.
- Work plan for assigning water retention areas and recovery measures
- Work plan for improving water management institutions
- Work plan for creating understanding, acceptance, and participation in large scale flood management from all stakeholders.

What is the Weakness of the Master Plan?

Though the master plan nominally consists of both the master plan for infrastructural investment, rehabilitation and maintenance, and the non-infrastructural management plan, the government does not give much attention to the latter. No concrete policy nor any measures have been proposed, e.g., (a) no concrete proposal on how to compensate farmers in the flood retention areas, (b) too little attention to the issue of drought, given the increasing incidence of extreme weather, and (c) inadequate attention to the complex long-term issues of fragmented water management and required institutional changes in integrated water management to cope with extreme weather conditions, plus the appropriate combination of a single command authority and decentralization. The most challenging issues are how to create effective coordination of more than 40 government agencies with overlapping responsibilities, and what is the appropriate combination of single command authority and decentralization of power.

There are also some crucial policies that are still missing, i.e., a policy to facilitate farmers' adaptation in the flood retention areas, and a water management institution. The plan is also silent on adaptation to climate change, which includes drought management. There are, therefore, research needs in the areas of adaptation strategies, water management institutions, and compensation measures. It is also important to bring attention to the enforcement of work plans and consistency in carrying them out, because practical strategies can only be effective when they are enforced in a consistent manner.

3. Impact of the 2011 Flood on Agricultural Output

This part of the discussion will first compare the farm areas damaged by floods as reported by the Ministry of Agriculture and Cooperatives (MOAC) and DDPM with information obtained from satellite images. Then it will update the World Bank's estimate of loss of agricultural output caused by the 2011 flood. The update will employ a new set of secondary data from GISTDA radar satellite images which were taken weekly between May and December 2011, with 50×50 meters resolution. Finally, it will compare the estimated agricultural loss and damage with the reported compensation paid by the MOAC and the DDPM.

In estimating the land areas that were damaged by floods, the researchers will use the Thai government's definition of 2-week flood duration as the criterion for payment of compensation to farmers whose farms were damaged by floods. Therefore the weekly satellite images that were taken between May and December 2011 are overlaid and the districts/ sub-districts that were inundated for at least two consecutive weeks are identified. At the same time the land-use pattern is also overlaid so that the inundated farm lands by broad types of agricultural product can be identified. Then, the farm lands that were inundated for at least 2 weeks will, in turn, be used as the new proxy for damaged farm land in the estimate of agricultural output loss.

The first question is how serious was the effect of flood on agricultural land? GISTDA only has information on the duration of flooding, classified by land use. It still does not have a digitized elevation map (DEP). The land use pattern is obtained from the Department of Land Development which carried out a survey during the period 2006-09.

Table 2 compares the flooded agricultural areas estimated from the satellite images with the agricultural areas "damaged by flood" as reported by the farmers to the Department of Agricultural Extension (DOAE) and the Department of Disaster Prevention and Protection (DDPM). One striking observation is that the flooded areas in all Central provinces are larger than the damaged farm areas.

Table 2: Flooded Agricultural Areas Reported by MOAC GISTDA and DDPM in Selected Provinces (hectares)

Region/Province		Flooded Agricultural Areas			Agricultural Areas		Province Areas[6]
		MOAC[1]	GISTDA[2]	DDPM[3]	DLD[4]	DOAE[5]	
Lower North		**2,577,137**	**1,932,026**	**2,677,864**	**11,756,120**	**10,298,133**	**19,430,794**
	Phitsanulok	654,923	639,469	785,519	3,113,389	3,006,736	6,622,288
	Phichit	516,432	447,234	501,666	2,347,494	2,198,034	2,699,381
	Nakhon Sawan	1,353,032	789,740	1,353,032	4,636,802	4,361,396	5,953,538
	Uthai Thani	52,750	55,583	37,647	1,658,436	731,967	4,155,588
North East		**2,120,011**	**2,037,427**	**2,172,839**	**28,934,864**	**21,398,868**	**40,307,785**
	Kalasin	180,614	191,272	227,360	3,175,170	2,308,026	4,335,194
	Khon Kaen	352,624	252,681	352,624	4,731,818	4,183,528	6,662,175
	Maha Sarakham	223,760	76,062	211,803	2,919,249	2,234,707	3,504,863
	Roi Et	536,674	778,489	617,625	3,937,468	3,551,380	4,920,269
	Si Sa Ket	233,656	284,247	89,280	4,174,315	2,505,799	5,584,435
	Surin	244,429	219,818	325,990	4,266,633	2,792,141	5,533,919
	Ubon Ratchathani	348,254	234,858	348,157	5,730,211	3,823,287	9,766,931
Central		**1,686,235**	**6,310,333**	**1,691,645**	**16,959,195**	**13,530,730**	**25,806,307**
	Chai Nat	118,256	345,266*	154,264	1,285,915	1,210,201	1,567,000
	Sing Buri	88,519	284,290	178,290	395,921	407,382	510,764
	Ang Thong	96,038	352,659	97,277	462,151	464,568	594,065
	Ayutthaya	356,482	568,393*	97,665	1,249,922	689,929	1,592,079
	Lop Buri	386,522	402,164	573,507	2,879,391	2,419,975	4,064,213
	Saraburi	110,130	185,483	120,381	1,252,214	924,089	2,180,102
	Suphan Buri	35,018	294,115*	64,458	2,521,942	2,227,827	3,379,156
	Nakhon Pathom	101,317	327,997*	39,429	950,553	814,300	1,338,940
	Pathum Thani	80,740	239,034*	n/a	568,046	393,895	950,744
	Nonthaburi	68,226	120,299*	105,095	234,505	180,637	397,751
	Samut Sakhon	5,313	3,728	n/a	324,351	119,861	541,525
	Chachoengsao	94,909	94,565*	94,437	2,292,061	1,740,712	3,231,100
	Nakhon Nayok	88,985	186,411*	112,811	700,327	502,223	1,338,094
	Bangkok	907	52,536*	n/a	258,488	174,917	980,000
	Prachin Buri	54,873	15,556*	54,031	1,583,409	1,260,214	3,140,775

Note: * Adjusted as follows: adjusted flooded farm land= GISTDA flooded farm land – (DLD farm land in 2006 – DOAE farm land in 2011).
** Flooded area (between Sep. 28 – Oct. 29, 2011)

Source: (1) Ministry of Agriculture and Cooperatives; (2) Geo-Informatics and Space Technology Development Agency, Radar Satellite Images; (3)Department of Disaster Prevention and Mitigation, Flooded Agricultural lands that were damaged and claimed for compensation; (4) Department of Land Development, Land Use Pattern; (5) Department of Agriculture Extension; (6) Ministry of Interior.

There are two explanations. First, the estimates of agricultural land from the satellite images are based on the land-use survey by the Department of Land Development (DLD) in 2006-2009. The latest estimates of agricultural land (from farmer registration) by the DOAE are smaller than that of DLD, particularly in some rapidly

developing provinces such as Ayuthaya, Lopburi, Saraburi, Supanburi, Nakorn Pathom, Pathum Thani, and Chachoengsao where large areas of farm land have been converted into areas of non-agricultural use (see columns 5-6 in Table 2). Secondly, since the flood travelled slowly, there was adequate time for the farmers in the lower part of the Central Plains to harvest their paddy, provided that their crop was ready for harvest. This is what happened in Supanburi where sluice gates were kept closed for more than a week so that farmers had time to harvest most of their paddy. It explains why the reported damaged farm areas in the Cental Plains were very small, i.e., 1.69 million ha, compared with 6.31 million ha of flooded farm land estimated from the satellite images and DLD survey.

Therefore, the flooded farm areas from GISTDA need to be revised by subtracting the difference between farm land estimated by DLD and that by DOAE from the flooded agricultural lands estimated from satellite images. A second method of performing this estimation is to re-estimate the land area that were flooded for two consecutive weeks, and calculate the ratio of farm lands that were flooded for at least two weeks to total farm land in each district. This ratio is then used to estimate the loss of agricultural output.

Table 3: Number of Districts and Provinces by Share of Their Agricultural Areas that were Flooded for at least Two Weeks

Farm area flooded at least 2 weeks/ district farm area	No. of districts where farm areas were flooded for 2 weeks +			
	Number of districts[1]		Number of provinces	
	GISTDA[2]	DDPM[3]	GISTDA	DOAE[4]
0%	13	14	-	-
1 - 20%	32	88	10	18
21 - 40%	19	31	5	6
41 - 60%	20	13	5	1
61 - 80%	28	6	1	1
80 - 100%	47	-	5	-
> 100%	-	7	-	-
Total	159	159	26	26

Note: (1) Excludes Bangkok and Northeast region. (2) Flooded farm areas from satellite images divided by farm areas surveyed by Department of Land Development in 2006-09. (3) Farm areas damaged by flood as reported by DDPM divided by farm areas surveyed by DOAE in 2011. (4) Provincial flooded farm areas reported by Ministry of Agriculture divided by farm areas surveyed by DOAE in 2011.

Source: Calculated from (1) GISTDA, satellite images; (2) Department of Land Development, Land Use Pattern; (3) DDPM, Reported Loss and Damages Caused by Flood between July and December 2011.; (4) Department of Agricultural Extension, Reported Damaged Agricultural Land Caused by Flood between July and December 2011.

Table 3 compares the ratio of two-week flooded farm lands (from satellite images) with the ratio of damaged farm lands (calculated from the data collected by the DOAE and DDPM). One observation is there are more districts and provinces that have higher ratios of flooded farm land in the GISTDA data set than those in the DOAE and DDPM data sets. But the DDPM reports 7 districts where damaged areas were larger than their total agricultural land.

Revising the World Bank Estimates of Loss in Agriculture

The World Bank's estimates of agricultural loss and damage were based on only one important parameter, i.e. the flooded areas reported by MOAC. [8] This study will use the satellite images of farm lands that were flooded for at least 2 consecutive weeks to estimate the loss of agricultural output. This should provide a better estimate because the information is science-based and is free from any moral hazard problems in the MOAC report. In fact, one can estimate agricultural loss more accurately if there is information both on the length of the flooding and the depth of the flood waters. Most, if not all, plants and permanent trees die after two weeks of immersion. Table 4 shows that the number of sub-districts (tambons) that were flooded for at least 2 weeks is smaller than the number of sub-districts that were flooded for at least one day. Moreover, floods were more serious in a few provinces in the Central Plains as most or all sub-districts (tambons) in the province were flooded for more than 2 weeks, e.g., Ayuddhaya, Ang Thong, Singburi and Patum Thani. So using the one-day flood duration, as in the World Bank study, will bias upward the agricultural loss and damage estimate. Moreover if plants are submerged under water for a few days, they will not die. Unfortunately, GISTDA does not yet have any DEM (digital elevation map) data. In addition to such information, the satellite images should be regularly confirmed by a systematic process of calibrating the satellite images with reality on the ground (known as a "ground-truthing" survey). Again the Thai government does not adequately invest in these activities.

Table 4: Number of Tambons that were Flooded for at least One Day and at least Two Weeks by Regions and Provinces

Regions	Provinces	Numbers of tambons		
		Flooded>1 day	Flooded>14 days	Total number
Central Plains		1230	1121	1349
	Ang Thong	73	73	73
	Ayutthaya	207	207	209
	Bangkok (no. sub-districts)	137	90	169
	Chachoengsao	91	87	93
	Chainat	51	50	53
	Lopburi	85	72	124
	Nakorn Nayok	39	39	41
	Nakorn Patom	126	118	106
	Nontaburi	52	52	52
	Patum Thani	60	60	60
	Prachinburi	58	55	65
	Samut Sakorn	31	15	40
	Saraburi	90	76	111
	Singburi	43	43	43
	Supanburi	87	84	110
North		284	269	382
	Nakorn Sawan	100	91	130
	Phitsanulok	47	44	93
	Pichit	81	81	89
	Utai Thani	56	53	70
North East		791	503	1244
	Kalasin	42	20	135
	Khon Kaen	109	75	199
	Mahasarakham	91	54	133
	Roi Et	178	134	193
	Sri Saket	157	81	206
	Surin	96	62	159
	Ubon Ratchathani	118	77	219
Total 26 Provinces		2305	1893	2975

Source: Calculated from (1) GISTDA, radar satellite images; (2) Bangkok Metropolitan Authority, districts and sub-districts that were classified as most severely flooded (red) and heavily flooded (orange).

Table 5 compares the World Bank estimates of agricultural loss and damage with estimates from two different sources of data. The first estimates (in column 8-10) are based on the flooded farm lands that were reported by the DOAE, while the second estimates (column 11-13) use GISTDA's data on the "ratio" of farm lands that were flooded for at least two weeks. The World Bank estimates of crop loss and damage are higher than those based on the information from both the DOAE and GISTDA. This is because the World Bank estimates were done when the flood had not yet receded and several bold assumptions had to be made. On the other hand, the World Bank estimates of damage for livestock and fishery were lower than the new estimates. This is because the new estimates of fishery loss are based on more

complete (and thus higher) estimates of the cost of losses in fresh water fish production. The new estimates of livestock losses are also based on the latest survey information by the Ministry of Agriculture (Department of Livestock Development). One important observation from Table 5 is that the estimates which are based on the ratio of farm lands that were flooded for at least two weeks are lower than both those of the World Bank and the estimates based on the damaged farm lands reported by the DOAE.

Table 5: Comparing Estimates of Damages and Loss in Agriculture Sector

(Million USD)

Sector	World Bank (Million USD)			MOAC (Million USD)			GISTDA (Million USD)		
	Damage	Losses	Total	Damage	Losses	Total	Damage	Losses	Total
Agriculture	482.4	426.6	909.0	291.5	288.9	580.3	210.9	212.2	423.0
- Paddy	471.3	323.5	794.8	283.3	228.5	511.8	204.7	162.5	367.5
- Field Crops	2.6	19.9	22.5	3.3	18.3	21.5	1.3	14.0	15.3
- Permanent crops	8.5	83.2	91.7	4.9	41.8	47.0	4.9	35.3	40.1
Livestock*	95.3	0.0	95.3	115.5	0.0	115.5	115.5	0.0	115.5
Fishery*	4.6	0.0	4.6	12.1	0.0	12.1	12.1	0.0	12.1
Grand Total	582.3	426.6	1008.9	419.1	288.9	708.0	338.5	212.2	550.3

Note: MOAC Ministry of Agriculture and Cooperatives DDPM Department of Disaster Prevention and Mitigation, Ministry of Interior
* mostly property damage

Sources: (1) The World Bank 2011 and 2012; (2) MOAC and DDPM; (3) Authors' estimates based on data on farm land s that were flooded for at least two weeks from GISTDA, Land Development Department, Bangkok Metropolitan Authority.

Since the government paid large amounts of compensation to the farmers for part of their loss and damage (Table 6), it is interesting to compare the compensation with our estimates of loss and damage. Table 7 lists the compensation criteria, while Table 6 shows the actual compensation paid to the farmers as at February 3rd 2012. Total farm compensation was USD 557.5 million, plus USD 348 million for farm (and house) property damage to be paid by the DDPM. The total compensation is 65 % higher than our estimates of total farm loss and damage. It is possible that there may be moral hazard in the farmers' claim for compensation. One reason is that the compensation payment structure may have distorted the farmers' reports of actual loss and damage. Although the compensation for each type of crop is fixed at an amount based on some percentage of production costs, there is no limit to the amount of crop lands for which claims for flood damage could be made (see compensation criteria in Table 7). But there are limits on the number of livestock and the amounts of fish

production for which claims could be made. This is why the compensation for livestock and fishery losses is relatively low.

It should also be noted that both the World Bank's and our estimates do not include the loss of livestock and fishery production. Yet our estimates of livestock damage (3.54 billion baht in Table 3) is several times higher than the compensation payments in Table 4; while our fishery damage estimate (USD 4.47 million) is much lower than the actual compensation (USD 35.58 million). This implies that if the World Bank methodology is to be used in the future, it has to be properly modified.

Table 6: Compensation for Farmers Affected by 2011 Flood

Flood compensation (USD Million)	26 Provinces	19 Provinces
Department of Agriculture Extension	514.7	351.9
Department of Livestock Development	7.4	6.9
Department of Fisheries	35.4	33.0
Total	557.5	391.8

Source: Department of Agriculture Extension, Department of Livestock Development and Department of Fisheries.3 February 2012

Table 7: Compensation Criteria

Issues	Compensation
Crop	
Loss of crops and opportunities to grow in the regular seasons	Government compensation in case of 100% damaged production (unlimited amounts of lands) Rice: 2,222 bht/ rai Crop Fields: 3,150 Baht/ rai Permanent Trees: 5,098 Baht/ rai For partial damage, the compensation is 2,549 baht/rai
Damaged lands	- In the case of landslide, the compensation is 7,000/rai, max 5 rais - 400 bht/ rai for cleaning up the lands, max 5 rais
Higher price of inputs	-Government promises to provide seeds to farmers, i.e., 10 kgs of rice seeds for 1 rai with max 10 rais.
Livestock	
Loss of stocks	The amount of compensation varied depending on the types of the stocks and their ages i.e.
Higher prices of inputs (no compensation)	Pigs: less than 1 mth: 1,200 bht/ head, more than 1 mth: 2,500 bht/ head, max 10 heads each farmer
Livestock's sickness	-Providing veterinarian services and supplements to the livestock
Fishery	
Loss of fish stock	All fish: 4,225 baht per rai, max 5 rais
Higher price of inputs (no compensation)	Shrimps, Crabs and Clams: 10,920 baht per rai, max 5 rais Caged Fish: 315 baht per sq.m, max 80 sq.m

Note: (1) One rai equals 0.16 ha; (2) Baht 30.6366 equal one USD.
Source: Ministry of Agriculture and Cooperatives

4. Impact on Household Income and Expenditure

This part will estimate the impact of the 2011 flood on household income and expenditure. It will first compare the incomes and expenditures of households in the flooded sub-districts in quarters 1-3 (the non-flooding period) with their incomes and expenditures in the fourth quarter (the flooding period) of 2011. The incomes and expenditures of the flooded households will also be compared with those of non-flooded households for both periods. Secondly it will compare household income and expenditure in the fourth quarter of 2011 (the flooding year) with those in 2009. Thirdly, it will develop a "difference in difference" approach to measure the impact of flooding, using the quantile regression technique.

4.1. Method of Estimation of the Flood Impact

The "difference - in - difference" approach to measure the impact of the flood can be described by the following equations.

(1) $Y_{ist} = \alpha + \tau D_{s*}D_t + \beta D_s + \delta D_t + \varepsilon_{st} + \mu_{ist}$

(2) $\bar{Y}_{11} = \bar{Y} + \tau + \beta + \delta + \varepsilon_{11}$ where $\alpha = \bar{Y}$

(3) $\bar{Y}_{10} = \bar{Y} + \beta + \varepsilon_{10}$

(4) $\bar{Y}_{01} = \bar{Y} + \delta + \varepsilon_{01}$

(5) $\bar{Y}_{00} = \bar{Y} + \varepsilon_{00}$

(6) $\bar{Y}_{11} - \bar{Y}_{10} = \tau + \delta + \varepsilon_{11} - \varepsilon_{10}$

(7) $\bar{Y}_{01} - \bar{Y}_{00} = \delta + \varepsilon_{01} - \varepsilon_{00}$

(8) $(\bar{Y}_{11} - \bar{Y}_{10}) - (\bar{Y}_{01} - \bar{Y}_{00}) = \tau + (\varepsilon_{11} - \varepsilon_{10}) - (\varepsilon_{01} - \varepsilon_{00})$

(9) $E[(\bar{Y}_{11} - \bar{Y}_{10}) - (\bar{Y}_{01} - \bar{Y}_{00})] = \tau + E[(\varepsilon_{11} - \varepsilon_{10}) - (\varepsilon_{01} - \varepsilon_{00})]$
$= \tau$

Where

Y_{ist} = income of household i, living in area "s" in the "t" period

s = 0 if non flood areas
= 1 if flooded areas (19 or 26 provinces)

t = 0 if non-flooded months (January-September)
= 1 if flooded months (October- December)

D_s = Area dummy

D_t = Monthly dummy

$(\bar{Y}_{01} - \bar{Y}_{00})$ = change in income between 2 periods in non-flooded areas (control)

$(\bar{Y}_{11} - \bar{Y}_{10})$ = change in income between 2 periods in flooded areas (treatment)

$(\bar{Y}_{11} - \bar{Y}_{10}) - (\bar{Y}_{01} - \bar{Y}_{00})$ = direct effect of flood

What is a Quantile Regression?

To estimate the effect of flood on income and expenditure, equation (1) is estimated using the quantile regression technique (Firpo, *et al.,* 2009).

A quantile regression is a new method to evaluate the impact of changes in the distribution of the explanatory variables on quantiles of the unconditional (marginal) distribution of an outcome variable. The method consists of running a regression of the (re-centered) influence function (RIF) of the unconditional quantiles on the explanatory variables.

The following statement is a brief summary of the quantile regression: " Whereas the method of least squares results in estimates that approximate the conditional *mean* of the response variable given certain values of the predictor variables, quantile regression aims at estimating either the conditional median or other quantiles of the response variable…….One advantage of quantile regression, relative to the ordinary least squares regression, is that the quantile regression estimates are more robust against outliers in the response measurements." (Wikipedia, "Quantile Regression").

4.2. Data Sources

1) NSO, 2009 and 2011 Socio-Economic Survey. Note that SES did not ask any question on 2011 flood.
2) GISTDA, Satellite Images on a list of flooded tambons (sub-districts).

Since the Socio-economic Survey contains data on the address of the households, especially the names of village and tambons, this allows the researchers to identify the tambons that were flooded when the information from SES is matched with the satellite images. As a result, we can identify the households that were affected by floods in 19 provinces in the Lower North and Central Plains and 7 Northeastern provinces. The period of flood was between May and December 2011.[9] Note that all households in Bangkok were treated as flooded households, despite the fact that some districts in Bangkok were not flooded, because the satellite images do not allow us to identify flood in cities with a high density of buildings.

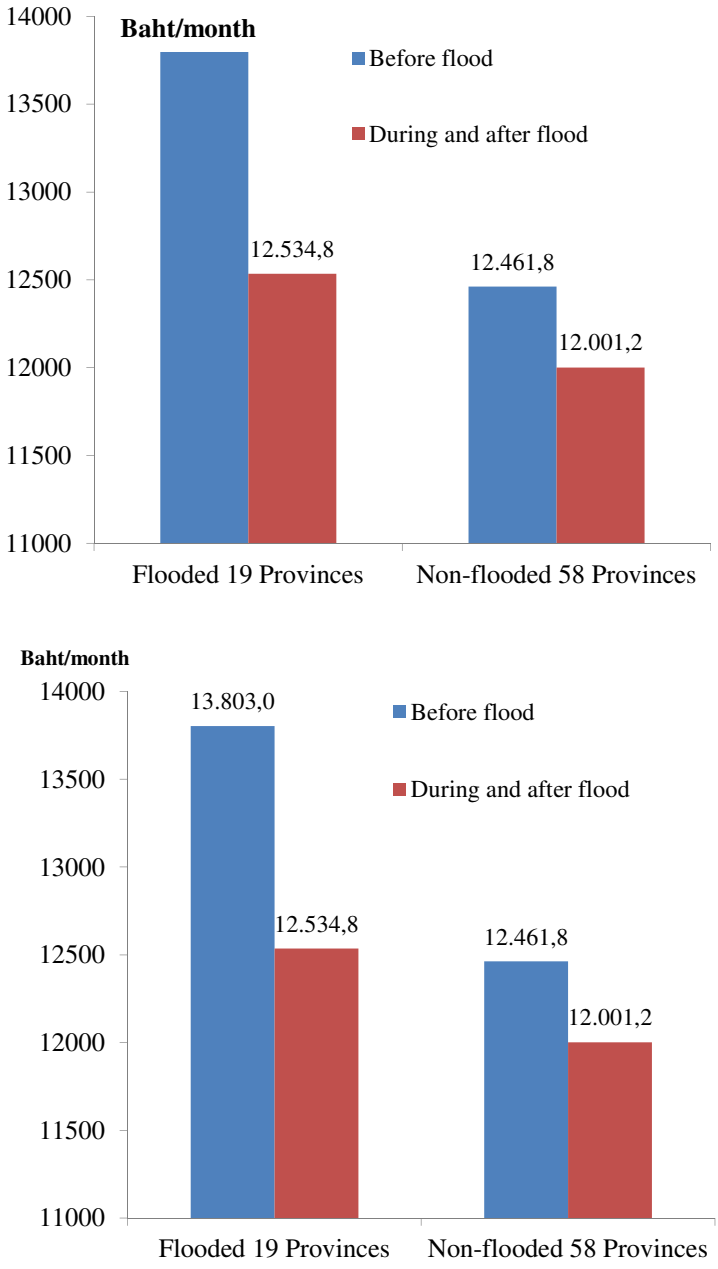
4.3. Tabulation of Impact on Expenditures

In general, the 2011 floods had negative effects on expenditure and income of flooded households in the flooding period (Figure 8 and Figure 9). The expenditures of households in the non-flooded areas were also affected but to a smaller extent

(Table 8). One possible explanation of the indirect effect on those who live outside the flooded areas is that the flood in the most important business and industrial areas might have had a spill-over effect throughout the whole economy. The impact works through three channels of the supply chain effect, i.e., (a) a shortage of raw materials, parts and components for industrial plants outside the flooded area; (b) the loss of jobs or reduction of income as a result of the closure of industrial plants and firms; and (c) disruption of logistics.

The flood impact on household expenditures in 19 provinces was larger than that in 26 provinces because the flood was more severe in 19 provinces in the Lower North and Central Plains than the other 7 provinces in the Northeast. Households did not reduce expenditures across the board. Instead, they incurred higher expenditures on hiring household services (see Table 8). The expenses that were reduced by the largest percentage we cloth, transportation, housing, medical expenses, personal care, toys & sport activities, and eating out, respectively.

Figure 8: Impact of Flood on Household Monthly Expenditure



Note: Baht 30.637 equal one US$

Source: NSO, Socio-economic Survey, 2011

Table 8: Effect of Flood by Type of Expenditure (baht per month)

Expenditure	Flooded 19 Provinces				Flooded 26 Provinces			
	Before flood	During and after flood	Total	%	Before flood	During and after flood	Total	%
A1.Housing and household operation	3,968.9	3,444.5	3,834.9	-13.2	3,698.6	3,389.7	3,621.3	-8.4
A2.Service workers in household	59.3	96.0	68.7	61.9	50.8	75.2	57.0	48.0
A3.Cloth-clothing material	574.4	408.2	531.9	-28.9	512.0	373.2	477.3	-27.1
A4.Personal care	662.7	599.9	646.6	-9.5	633.5	591.7	623.1	-6.6
A5.Medical and health care	297.8	259.1	287.9	-13.0	274.5	260.5	271.0	-5.1
A6.Transportation and communication	1,952.6	1,595.7	1,861.4	-18.3	1,779.0	1,535.6	1,718.1	-13.7
A7.Toys, pets, trees,sport and admissions	302.1	272.7	294.6	-9.7	272.4	270.7	272.0	-0.6
A8.Food	5,985.2	5,858.7	5,952.9	-2.1	5,868.6	5,939.3	5,886.3	1.2
A9.Alcoholic and non-alcoholic beverages	383.8	356.5	376.9	-7.1	366.0	351.4	362.3	-4.0
A10.Prepared food consumed at home, and	1,188.6	1,122.8	1,171.8	-5.5	1,162.4	1,124.6	1,152.9	-3.2
A11….consumed away from home	815.0	741.8	796.3	-9.0	781.1	752.2	773.8	-3.7

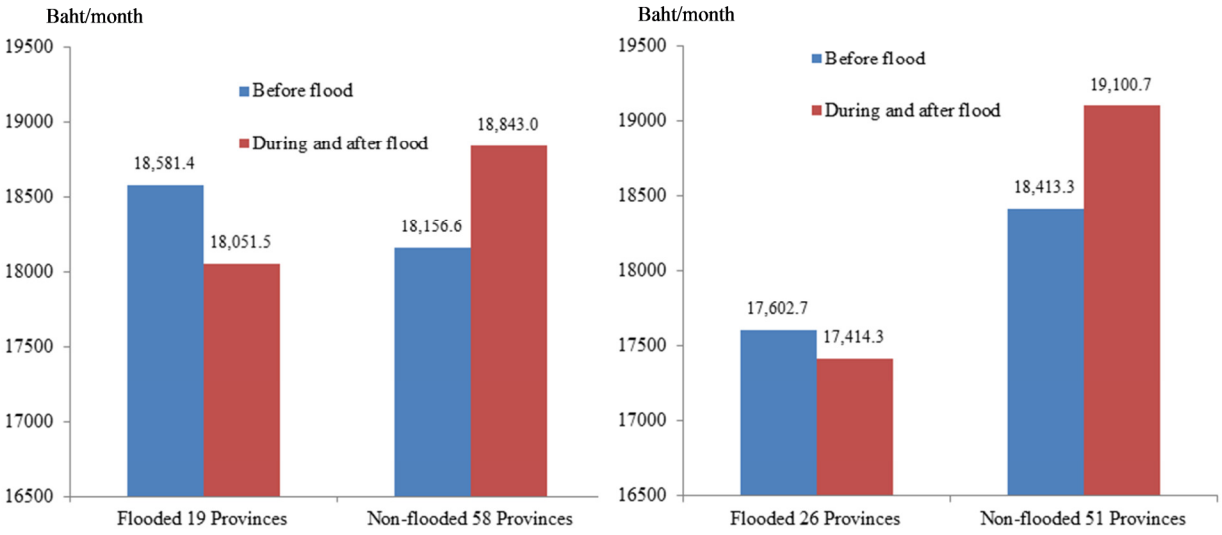
Note: Baht 30.637 equal one USD.
Source: NSO, Socio-economic Survey, 2011

4.4. Tabulation of Impact on Income

The 2011 floods had a negative impact on the money income of households in the flooded areas, while those in the non-flooded areas still enjoyed an increase in total money income (Figure 9 and Table 9). Yet, the flood had a negative impact on the wages & salary income of households in both the flooded and non-flooded areas (Table 9), implying that there was a negative spillover effect on wage employment throughout the country.

Despite the fact that most farm income occurs in October and December, it is surprising to find that there was no negative impact of flooding on farm income and profit from business. Thus, the appropriate way to measure the impact of flooding on farm income is to compare farm income in Q4/ 2011 with that in Q4/2009 (because there was no income survey in 2010). For business income, the result can be reconciled by the fact that household business might be able to make more net profit due to increased prices of consumer goods & services caused by the disruption of supplies. However, the price effect dominated the income effect of the flood, which resulted in lower household expenditures.

Figure 9: Impact of Flood on all Money Income



Note: Baht 30.637 equal one USD
Source: NSO, Socio-economic Survey, 2011

Table 9: Impact of Flood by Types of Income and Flooded Areas

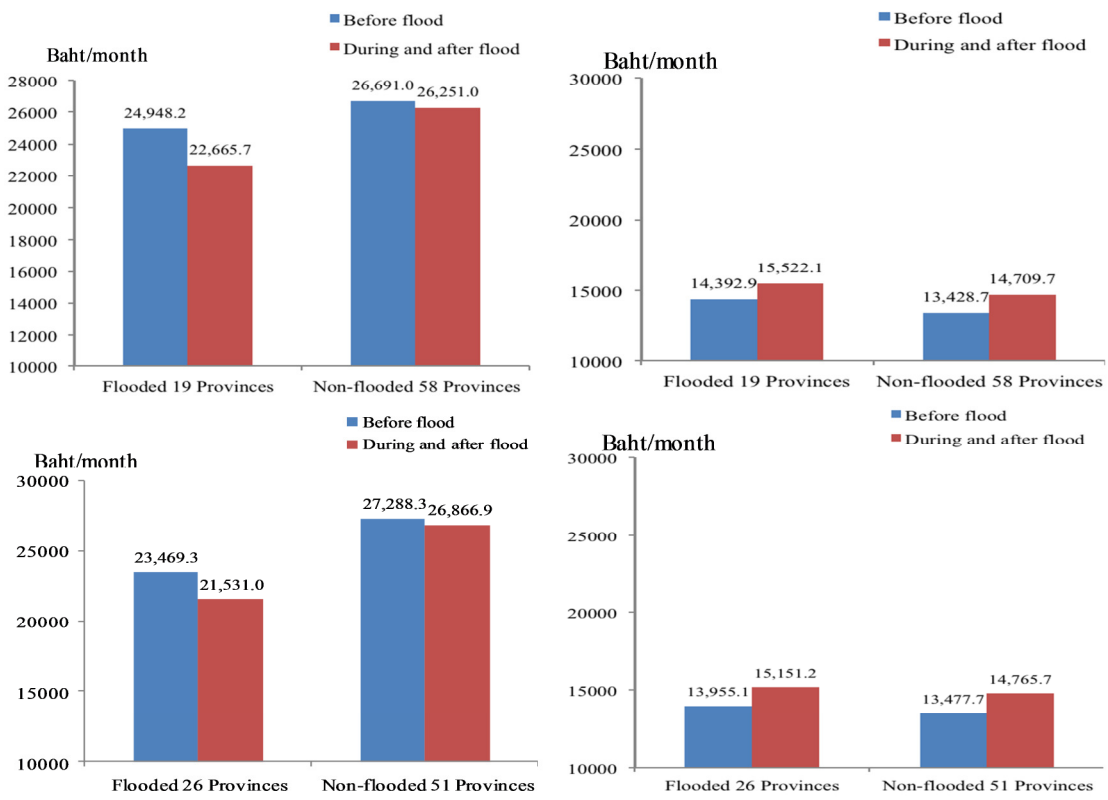
Province	Income	Flood months			%
		Before flood	During and after flood	Total	
Flooded 19 Provinces	All money income	18,581.4	18,051.5	18,446.0	-2.9
	Wage and salaries	11,538.7	9,911.5	11,123.0	-14.1
	Net profit from business	3,831.9	4,731.7	4,061.8	23.5
	Net profit from farming	694.9	812.2	724.9	16.9
Non-flooded 58 Provinces	All money income	18,156.6	18,843.0	18,321.2	3.8
	Wage and salaries	8,690.1	8,074.5	8,542.5	-7.1
	Net profit from business	4,385.6	4,466.1	4,404.9	1.8
	Net profit from farming	2,521.8	3,408.5	2,734.4	35.2
Flooded 26 Provinces	All money income	17,602.7	17,414.3	17,555.6	-1.1
	Wage and salaries	10,640.1	9,551.8	10,367.7	-10.2
	Net profit from business	3,661.7	4,379.2	3,841.2	19.6
	Net profit from farming	996.5	1,007.3	999.2	1.1
Non-flooded 51 Provinces	All money income	18,413.3	19,100.7	18,578.4	3.7
	Wage and salaries	8,738.1	8,050.4	8,572.9	-7.9
	Net profit from business	4,478.1	4,556.5	4,497.0	1.7
	Net profit from farming	2,572.2	3,540.3	2,804.7	37.6

Source: NSO, Socio-economic Survey, 2011

4.5. Tabulation of Impact by Areas

The income of urban households was more seriously affected than that of rural households, except for wages and salaries (Figure 10). While urban households suffered a decline in all types of income, their rural counterparts suffered only the reduction in wages and salaries.

Figure 10: Impact of Flood on Total Money Income by Areas



Note: Baht 30.637 equal one USD
Source: NSO, Socio-economic Survey, 2011

4.6. Tabulation of Impact by Months

Monthly expenditures declined during the flooding months (Figure 11-a). But there is no clear trend in the impact of the floods on monthly income (Figure 11-b).

Figure 11-a: Impact of Flood on Monthly Money Income

All money Income (Baht per month)

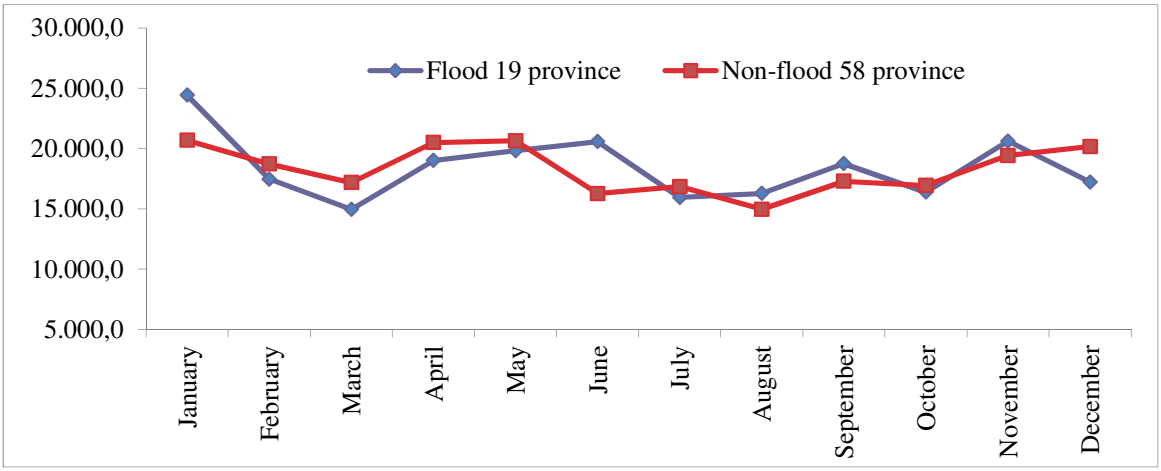
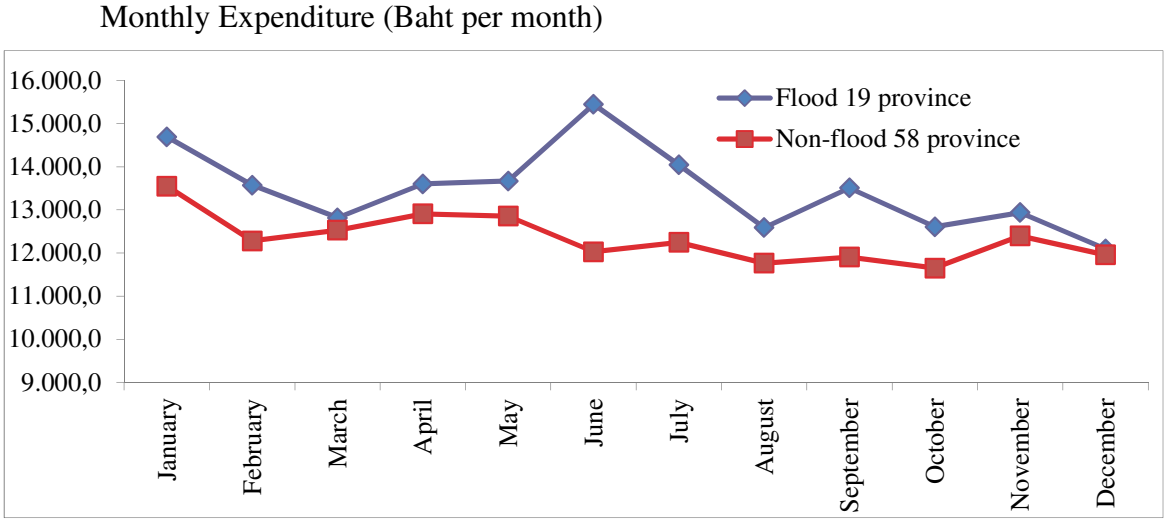


Figure 11-b: Impact of Flood on Monthly Expenditures



Note: Baht 30.637 equal one USD.
Source: NSO, Socio-economic Survey, 2011

4.7. Results from Quantile Regressions on Household Expenditures

Based on equation (1) in part 4.1, we ran two sets of regressions, i.e., one OLS regression and 20 quantile regressions to measure the impact of flooding on household expenditures and income. The households that were in the sub-districts that were flooded for at least one day during May and December 2011 are identified by matching the list of flooded sub-districts in the satellite images with that in the Socio-economic Survey in 2011.[10] The dependent variables are the household expenditures (in log form) and income (in level), while the independent variables include a dummy variable representing area that was flooded for at least two weeks (flodarea1), the flooding month dummy (t), an interaction between flooded area dummy and flooding month dummy (c.t#c.flodarea), and control variables, e.g., socio-economic and demographic characteristics. They are as follows: (1) years of education of household head, 'headsch'; (2) male household head dummy, 'malehead'; (3) married household head, 'headmarried'; (4) number of adult male family members, 'adultmale'; (5) number of adult female family members, 'adultfem'; (6) number of children aged 0-3 years, 'children03'; (7) number of children aged 4-15, 'children415'; and (8) number of older household members (aged 60 years and older), 'adult60'.

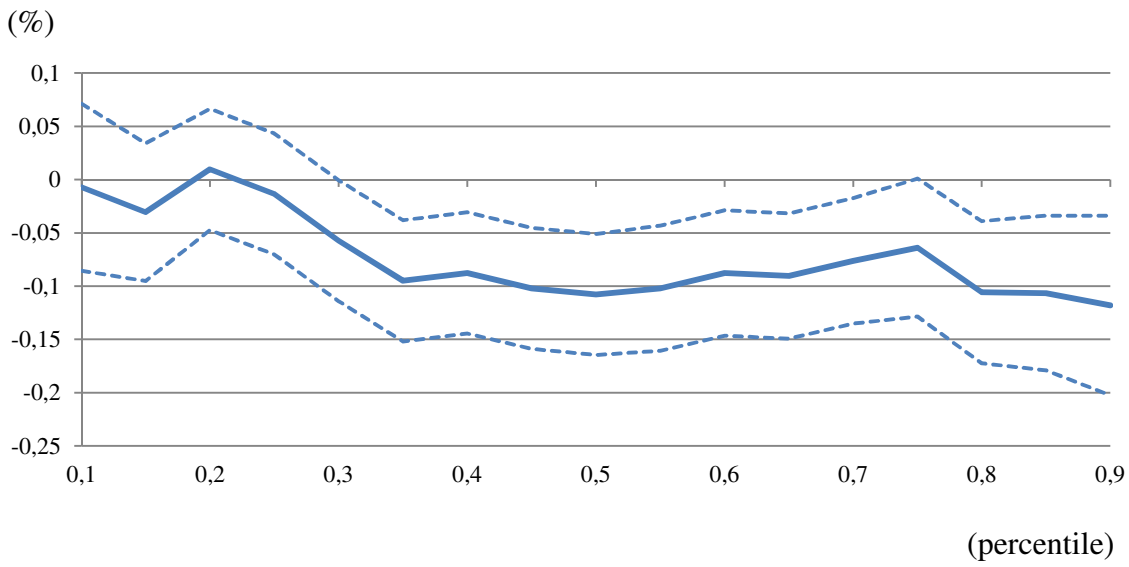
All control variables are statistically significant (Table 10). The flooded area dummy is significant in both the OLS and quantile regressions. But the flooding month dummy is statistically significant only in some quantile regressions. The

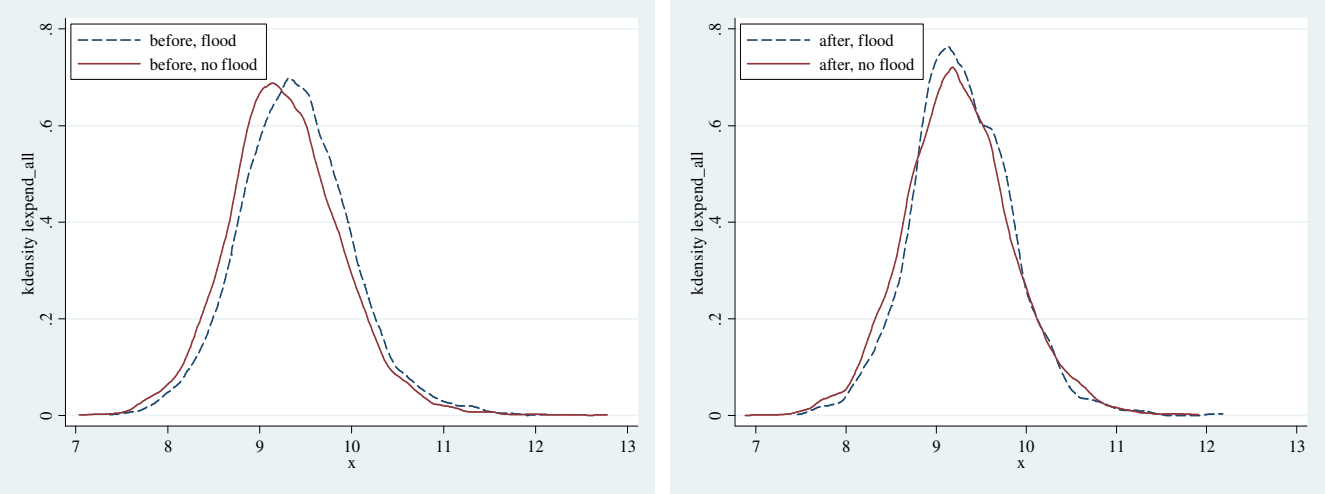
interaction of the flooding month dummy and the flooding area dummy is statistically significant in the OLS and most of the quantile regressions, except for a few lowest percentiles.

In the lower part of Figure 12, the expenditure distribution of households living in the flooded areas and non-flooded areas are compared in two periods, i.e., before and after the flood. Before the flood, the households in the flooded areas spent slightly more than those in the 56 non-flooded provinces, (with a higher value of mode). But after the flood, the former apparently reduced their spending.

The upper part of Figure 12 plots the flood impact on the percentage change of household expenditures, by percentiles. The 95% levels of change are also depicted. Floods caused the household expenditures to decline by 5.7 % to 14.1%, with an average of 6.7%. Flooding had a statistically significant impact on the expenditure of the households in the 30^{th} and higher percentile income classes. It is surprising that the poor households in the flooded areas did not spend statistically significantly less during the flooding months (Figure 12 and Table 10).

Figure 12: Flood Effect on Total Household Expenditure





Source: Calculated from NSO, *Socio-economic Survey*, 2011

Table 10: Flood Effect on Household's Expenditure

VARIABLES	lexpend_all	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	0.063***	0.043***	0.048***	0.046***	0.045***	0.045***	0.046***	0.048***	0.051***	0.053***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
malehead	-0.049***	-0.065**	-0.041**	-0.034**	-0.028**	-0.038***	-0.044***	-0.048***	-0.051***	-0.056***
	(0.009)	(0.026)	(0.020)	(0.017)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
headmarried	0.074***	0.307***	0.242***	0.198***	0.163***	0.140***	0.123***	0.106***	0.094***	0.082***
	(0.009)	(0.028)	(0.022)	(0.018)	(0.015)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)
adultmale	0.222***	0.186***	0.218***	0.210***	0.195***	0.202***	0.209***	0.212***	0.216***	0.218***
	(0.006)	(0.011)	(0.010)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
adultfem	0.289***	0.239***	0.269***	0.267***	0.264***	0.265***	0.270***	0.275***	0.278***	0.286***
	(0.006)	(0.012)	(0.010)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
children03	0.043***	0.040***	0.058***	0.075***	0.066***	0.074***	0.070***	0.072***	0.067***	0.069***
	(0.010)	(0.013)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)
children415	0.090***	0.128***	0.145***	0.135***	0.124***	0.119***	0.115***	0.111***	0.110***	0.104***
	(0.005)	(0.009)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
adult60	0.223***	0.084***	0.096***	0.106***	0.123***	0.133***	0.149***	0.162***	0.179***	0.193***
	(0.006)	(0.013)	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
t	-0.001	-0.001	0.018	0.031*	0.004	0.009	0.024*	0.023*	0.011	0.017
	(0.010)	(0.029)	(0.022)	(0.018)	(0.015)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)
flodarea1	0.105***	0.104***	0.129***	0.124***	0.122***	0.114***	0.119***	0.116***	0.129***	0.127***
	(0.009)	(0.021)	(0.018)	(0.015)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)
c.t#c.flodarea1	-0.067***	0.04	-0.007	-0.031	0.01	-0.013	-0.057**	-0.095***	-0.088***	-0.102***
	(0.020)	(0.048)	(0.040)	(0.033)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Constant	8.153***	7.315***	7.441***	7.631***	7.785***	7.887***	7.952***	8.021***	8.069***	8.122***
	(0.013)	(0.046)	(0.035)	(0.026)	(0.021)	(0.018)	(0.016)	(0.015)	(0.014)	(0.014)
Observations	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390
R-squared	0.463	0.112	0.173	0.22	0.248	0.268	0.281	0.291	0.298	0.301

Table 10: Flood Effect on Household's Expenditure (cont.)

VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	0.056***	0.060***	0.064***	0.066***	0.069***	0.074***	0.078***	0.083***	0.089***	0.104***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)
malehead	-0.055***	-0.051***	-0.052***	-0.053***	-0.055***	-0.066***	-0.066***	-0.058***	-0.045**	-0.018
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)	(0.015)	(0.017)	(0.020)	(0.029)
headmarried	0.066***	0.051***	0.031**	0.014	-0.003	-0.01	-0.034**	-0.064***	-0.095***	-0.113***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)	(0.015)	(0.017)	(0.020)	(0.030)
adultmale	0.221***	0.220***	0.220***	0.219***	0.222***	0.237***	0.237***	0.240***	0.247***	0.254***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.010)	(0.012)	(0.015)	(0.023)
adultfem	0.292***	0.302***	0.307***	0.301***	0.299***	0.309***	0.307***	0.306***	0.308***	0.323***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.010)	(0.012)	(0.015)	(0.024)
children03	0.063***	0.058***	0.060***	0.046***	0.056***	0.043**	0.034*	0.03	0.002	-0.074**
	(0.014)	(0.015)	(0.015)	(0.015)	(0.016)	(0.017)	(0.018)	(0.020)	(0.024)	(0.030)
children415	0.099***	0.094***	0.087***	0.079***	0.069***	0.065***	0.066***	0.043***	0.036***	0.015
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.010)	(0.011)	(0.016)
adult60	0.206***	0.220***	0.234***	0.247***	0.266***	0.284***	0.301***	0.326***	0.364***	0.442***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.011)	(0.014)	(0.023)
t	0.016	0.002	0.001	-0.001	-0.017	-0.029*	-0.030*	-0.026	-0.015	-0.011
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.017)	(0.018)	(0.022)	(0.030)
flodarea1	0.121***	0.120***	0.113***	0.102***	0.105***	0.098***	0.090***	0.068***	0.057**	0.04
	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)	(0.016)	(0.017)	(0.020)	(0.023)	(0.032)
c.t#c.flodarea1	-0.108***	-0.102***	-0.088***	-0.090***	-0.076**	-0.064*	-0.106***	-0.106***	-0.118***	-0.141**
	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)	(0.033)	(0.034)	(0.037)	(0.043)	(0.057)
Constant	8.172***	8.216***	8.278***	8.362***	8.431***	8.470***	8.565***	8.670***	8.786***	8.893***
	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)	(0.015)	(0.017)	(0.020)	(0.027)	(0.044)
Observations	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390
R-squared	0.304	0.301	0.299	0.294	0.289	0.274	0.253	0.224	0.182	0.126

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

Figure 13-a shows the impact of flooding on household expenditures, excluding housing expenses such as rent and maintenance. The result shows that the 2011 flood had more impact on the spending of middle income families than on households at both tails of the income distribution. The changes in food expenditures (Figure 13-b) show a similar pattern.

Political economy: The estimates confirm that the 2011 flood seriously affected the middle class, who constitute the largest voting constituency. This explains why the government hurriedly allocated 350 billion baht for the flood management plan, 300 billion baht of which came from an emergency law which empowers the government to borrow the money.

Figure 13-b and Table 11 show that the food expenditures of most income quintiles declined by 6%-12%. Most coefficients are statistically significant. Again the percentage decline in food expenditure for the middle income class is the highest.

Figure 13-a: Flood Effect on Total Household Expenditures (not including housing expenses)

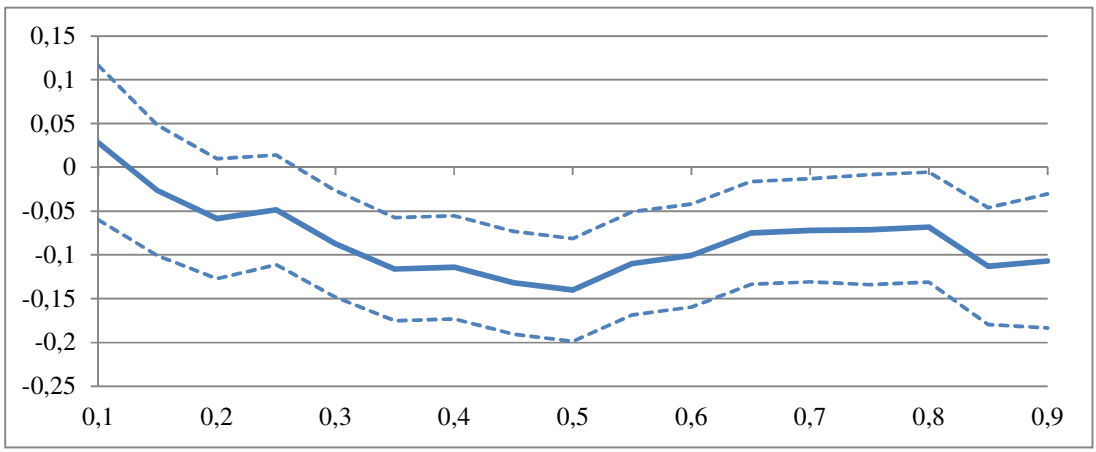
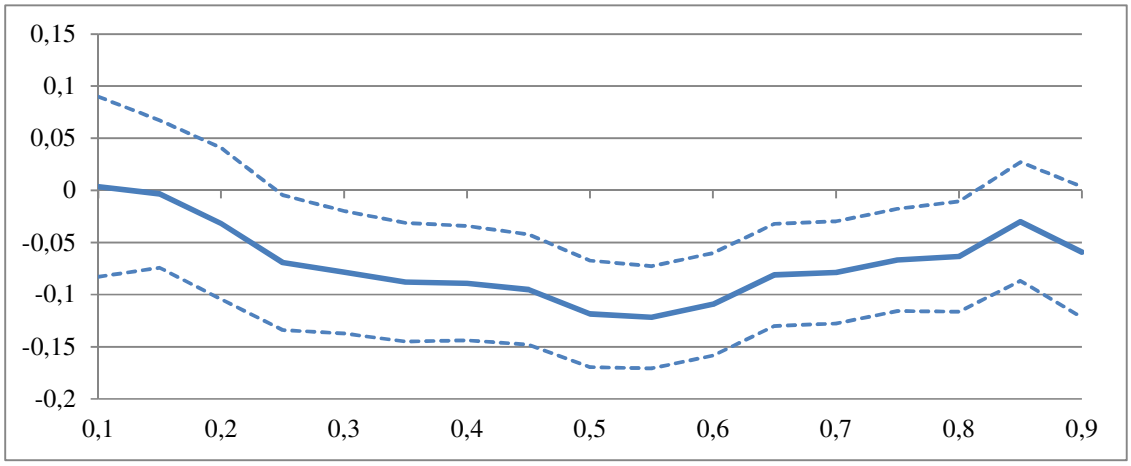


Figure 13-b: Flood Effect on Household Food Expenditures

(%)



(percentile)

Source: Calculated from NSO, *Socio-economic Survey*, 2011

Table 11: Flood Effect on Household's Food Expenditure (Dependent variable is log of food expenditure)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	0.028***	0.021***	0.025***	0.025***	0.027***	0.026***	0.025***	0.027***	0.028***	0.029***
	(0.001)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
malehead	-0.025***	0.023	0.01	-0.014	-0.025	-0.025*	-0.024*	-0.029**	-0.038***	-0.040***
	(0.009)	(0.033)	(0.022)	(0.018)	(0.016)	(0.014)	(0.013)	(0.012)	(0.012)	(0.011)
headmarried	0.114***	0.298***	0.292***	0.261***	0.247***	0.208***	0.185***	0.156***	0.138***	0.123***
	(0.010)	(0.034)	(0.024)	(0.019)	(0.018)	(0.015)	(0.014)	(0.013)	(0.012)	(0.011)
adultmale	0.212***	0.209***	0.206***	0.214***	0.230***	0.228***	0.223***	0.221***	0.222***	0.214***
	(0.006)	(0.014)	(0.011)	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
adultfem	0.235***	0.223***	0.237***	0.232***	0.266***	0.257***	0.249***	0.248***	0.243***	0.242***
	(0.006)	(0.015)	(0.011)	(0.011)	(0.010)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
children03	0.141***	0.084***	0.095***	0.099***	0.116***	0.129***	0.128***	0.148***	0.146***	0.143***
	(0.009)	(0.016)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)
children415	0.144***	0.165***	0.160***	0.158***	0.182***	0.173***	0.169***	0.160***	0.160***	0.152***
	(0.005)	(0.010)	(0.008)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
adult60	0.167***	0.120***	0.116***	0.119***	0.131***	0.131***	0.139***	0.147***	0.154***	0.151***
	(0.006)	(0.015)	(0.012)	(0.010)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)	(0.007)
t	0.01	-0.002	0.007	0.016	0.015	0.018	0.02	0.019	0.032**	0.018
	(0.010)	(0.034)	(0.024)	(0.019)	(0.018)	(0.015)	(0.014)	(0.013)	(0.013)	(0.013)
flodarea1	0.063***	0.131***	0.093***	0.083***	0.082***	0.089***	0.073***	0.069***	0.062***	0.063***
	(0.009)	(0.026)	(0.020)	(0.017)	(0.016)	(0.014)	(0.013)	(0.013)	(0.013)	(0.012)
c.t#c.flodarea1	-0.058***	0.037	0.004	-0.003	-0.032	-0.069**	-0.078***	-0.088***	-0.089***	-0.095***
	(0.019)	(0.057)	(0.044)	(0.036)	(0.037)	(0.033)	(0.030)	(0.029)	(0.028)	(0.027)
Constant	7.642***	6.622***	6.841***	7.027***	7.080***	7.228***	7.348***	7.433***	7.516***	7.608***
	(0.013)	(0.056)	(0.036)	(0.028)	(0.025)	(0.021)	(0.018)	(0.016)	(0.015)	(0.015)
Observations	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360
R-squared	0.375	0.07	0.132	0.176	0.215	0.244	0.263	0.275	0.278	0.28

Table 11: Flood Effect on Household's Food Expenditure (Dependent variable is log of food expenditure) (cont.)

VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	0.028***	0.030***	0.031***	0.031***	0.031***	0.031***	0.033***	0.033***	0.034***	0.038***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
malehead	-0.035***	-0.023**	-0.029***	-0.024**	-0.021*	-0.019*	-0.026**	-0.022*	-0.024	-0.02
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.013)	(0.015)	(0.019)
headmarried	0.103***	0.084***	0.065***	0.046***	0.025**	0.004	-0.01	-0.026**	-0.047***	-0.081***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.012)	(0.012)	(0.014)	(0.018)
adultmale	0.212***	0.207***	0.211***	0.204***	0.199***	0.205***	0.222***	0.217***	0.223***	0.211***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)	(0.011)	(0.016)
adultfem	0.235***	0.241***	0.236***	0.231***	0.222***	0.227***	0.223***	0.219***	0.225***	0.225***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.010)	(0.011)	(0.015)
children03	0.140***	0.159***	0.165***	0.160***	0.144***	0.153***	0.166***	0.170***	0.163***	0.169***
	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.015)	(0.016)	(0.018)	(0.020)	(0.028)
children415	0.147***	0.141***	0.140***	0.135***	0.127***	0.121***	0.122***	0.116***	0.111***	0.113***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.008)	(0.008)	(0.010)	(0.013)
adult60	0.154***	0.168***	0.171***	0.170***	0.172***	0.184***	0.199***	0.200***	0.211***	0.238***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.010)	(0.015)
t	0.017	0.018	0.021*	0.019	0.026**	0.025*	0.014	0.011	0.014	-0.002
	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.014)	(0.015)	(0.017)	(0.021)
flodarea1	0.065***	0.071***	0.060***	0.042***	0.037***	0.027**	0.011	0.013	0.02	0.022
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)	(0.016)	(0.021)
c.t#c.flodarea1	-0.118***	-0.122***	-0.109***	-0.081***	-0.079***	-0.067***	-0.063**	-0.03	-0.059*	-0.036
	(0.026)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.027)	(0.029)	(0.032)	(0.041)
Constant	7.696***	7.742***	7.823***	7.918***	8.014***	8.083***	8.155***	8.263***	8.376***	8.544***
	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)	(0.013)	(0.014)	(0.016)	(0.019)	(0.028)
Observations	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360	31,360
R-squared	0.277	0.278	0.268	0.26	0.245	0.229	0.206	0.181	0.15	0.1

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

4.8. Quantile Regression Results on Household Income

Since some households do not have every type of income, the dependent variable is total income level. But we also ran a subset of households who have at least one member who is a wage employee, using the log of monthly wage as a dependent variable.

We ran one OLS and 20 quantile regressions, i.e., every five percentiles. In general, the results of income regressions are mixed and not satisfactory, i.e., some key variables are not statistically significant with unexpected signs, e.g., the flooded area dummy and the interaction dummy which measure the impact of flooding.

Regression results on income effect of floods

In the OLS specification, the flooded area dummy is significant in 4 out of 5 equations of different types of income, but with positive sign in two wage regressions (Table 12). The interaction dummy is not statistically significant in all OLS regressions, with negative sign in three regressions.

With regards to the quantile regressions on total money income in Figure 14-a and Table 12, the interaction dummy (t*s) is significant for the 30^{th}, 35^{th}, 40^{th}, …, to 60^{th} , and 75^{th} to 95^{th} quintuple regressions. This means that the 2011 flood had relatively more negative impact on the middle class and very severe impact on the upper middle-income class.

Most of the impact comes from the reduction in wages and salaries of the upper middle-income households, i.e., the 50^{th}, 80^{th}, 85^{th} and 90^{th} quintuple regressions (Figure 14-b).

The interaction term is not statistically significant in any business profit regressions (Appendix Table A-1). It is significant with negative coefficients in four regressions on farm income, i.e., 15^{th}, 35^{th}, 55^{th} and 70^{th} (Appendix Table A-1). Figure 14-c plots the effect of floods on business profit.

All coefficients in the farm profit regressions are not statistically significant (not shown here). One drawback to the use of the 2011 Socio-economic Survey to measure the impact of floods on agricultural income is that the 2011 flood destroyed most, if not all, of the paddy output in the main crop which would be harvested in November and December. The use of regression to control for the socio-economic variables may not be able to capture the pure flood effect because the treatment groups, i.e., the affected

farmers in the flat land of the Chao Phraya River basin, have rather different physical farm characteristics from the farmers in the controlled (non-flood areas) group. This issue will be resolved in the following section by using the data on farm households in two different years.

Figure 14: Flood Effect on Household Income

a) Total money income

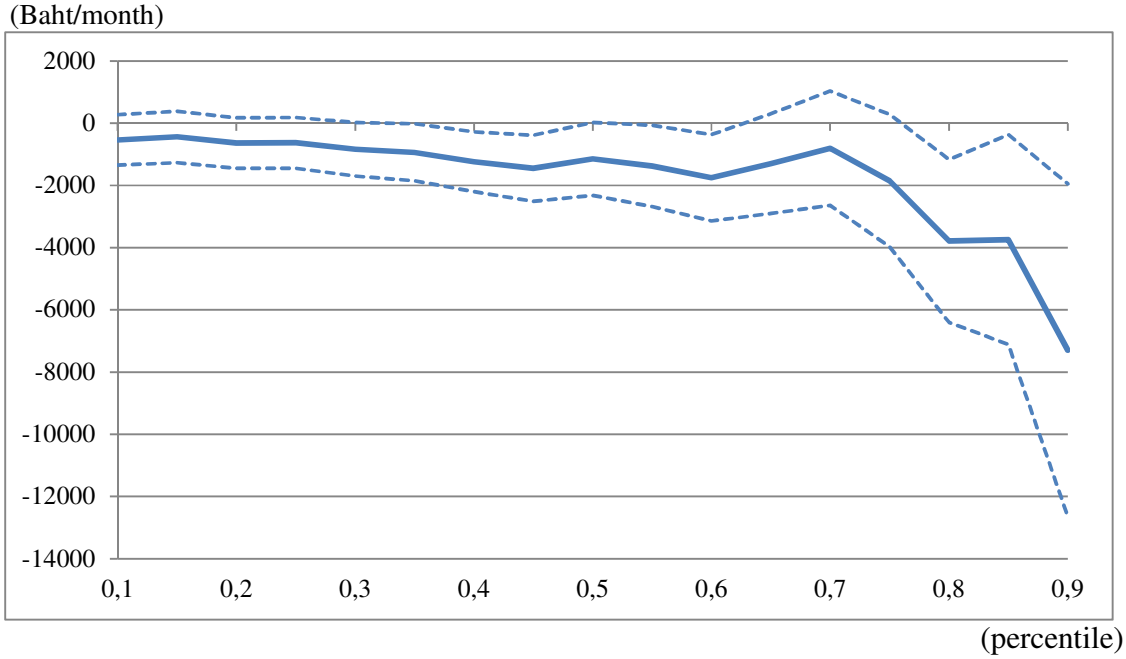
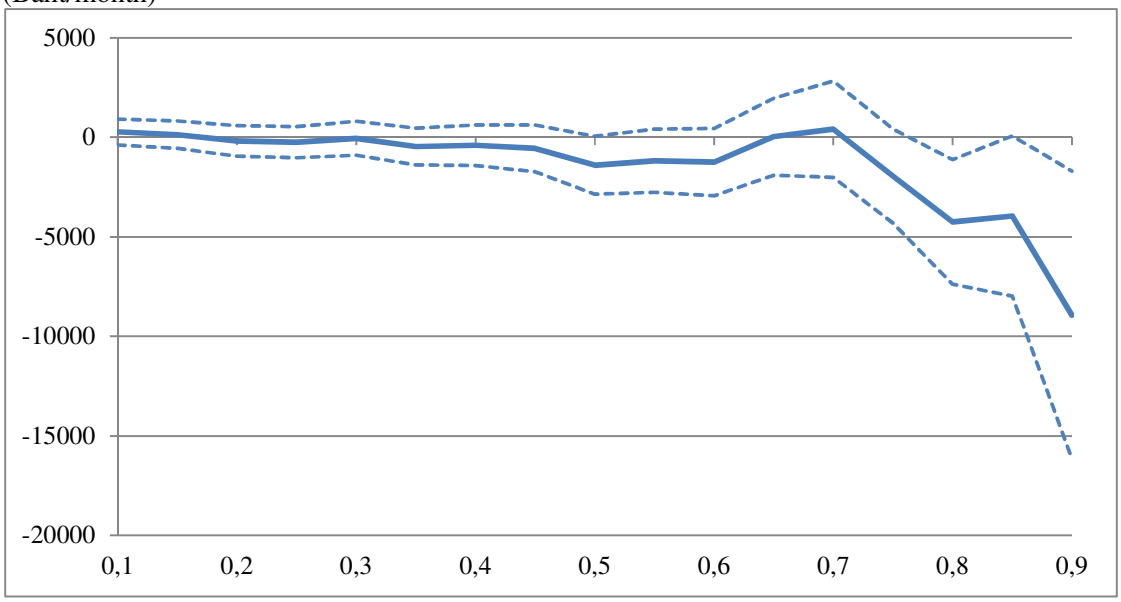


Figure 14: Flood Effect on Household Income (cont.)

b) Wages and salaries

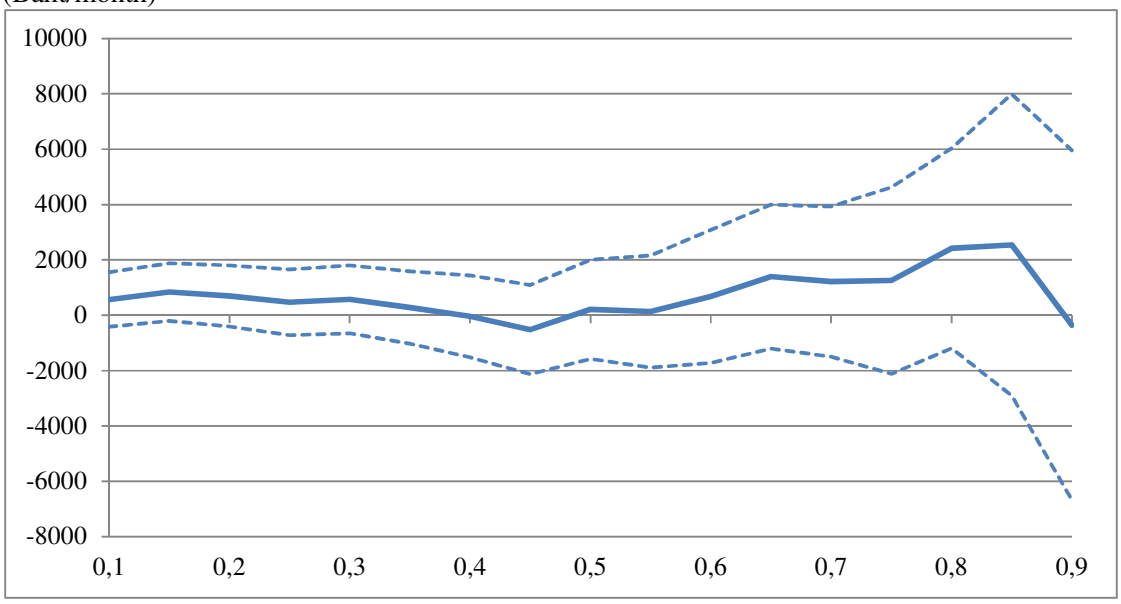
(Baht/month)



(percentile)

c) Profit from business

(Baht/month)



(percentile)

Source: Estimated from the quintile regressions of household income, wage and salary income (Tables 12 and 13) business profit (Appendix A-1) , using the 2011 Socio-economic Survey.

Table 12: Flood Effect on Total Household's Money Income (Dependent variable in money income per month)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	2,601.033***	166.356***	301.776***	438.830***	514.759***	610.272***	717.788***	832.265***	918.687***	1,075.344***
	(178.214)	(11.559)	(12.029)	(12.904)	(12.918)	(13.150)	(14.004)	(15.048)	(15.963)	(18.018)
malehead	-1,612.022**	-782.757***	-1,123.457***	-1,083.902***	-855.585***	-693.414***	-778.925***	-687.462***	-904.655***	-865.735***
	(691.253)	(134.219)	(161.962)	(177.764)	(178.525)	(179.074)	(185.630)	(197.865)	(209.070)	(233.177)
headmarried	516.068	-955.773***	247.901	411.742**	395.638**	423.185**	662.083***	830.994***	1,087.738***	1,159.963***
	(659.303)	(133.914)	(163.174)	(180.907)	(181.480)	(183.447)	(191.314)	(204.384)	(214.914)	(237.500)
adultmale	7,771.800***	104.387	579.785***	1,344.052***	1,664.146***	2,033.532***	2,426.419***	2,810.832***	3,182.181***	3,731.362***
	(782.590)	(77.649)	(87.586)	(94.290)	(96.801)	(100.388)	(105.611)	(114.632)	(122.389)	(137.997)
adultfem	8,059.988***	73.458	793.094***	1,494.909***	1,987.480***	2,415.860***	2,825.218***	3,297.497***	3,603.764***	4,148.529***
	(1,204.819)	(81.885)	(89.940)	(95.141)	(95.889)	(97.507)	(104.157)	(112.645)	(120.405)	(142.422)
children03	-3,033.535***	245.43	472.173***	399.381**	304.084*	129.776	229.139	-107.69	-295.551	-530.932**
	(833.362)	(154.907)	(147.183)	(170.317)	(175.191)	(189.951)	(200.661)	(218.026)	(232.727)	(259.271)
children415	28.415	19.229	443.243***	611.162***	706.615***	655.038***	513.782***	399.944***	300.968***	331.725***
	(578.616)	(80.798)	(80.829)	(87.927)	(89.360)	(94.109)	(100.157)	(107.568)	(114.239)	(126.993)
adult60	8,453.124***	1,145.138***	246.431**	289.293***	171.38	511.696***	746.378***	934.594***	1,258.387***	1,928.995***
	(1,060.894)	(82.507)	(98.227)	(106.581)	(108.302)	(109.575)	(114.241)	(122.221)	(128.387)	(141.028)
t	1,437.459*	583.203***	165.23	86.083	271.086	231.477	234.663	161.908	337.492	419.924
	(823.782)	(143.087)	(189.101)	(202.503)	(199.684)	(203.473)	(211.106)	(224.620)	(236.053)	(260.750)
flodarea1	-1,386.252*	-420.332**	-235.079	238.55	565.897***	834.800***	1,063.760***	1,092.097***	1,098.681***	1,329.123***
	(743.595)	(178.859)	(185.506)	(188.058)	(186.189)	(186.349)	(193.852)	(207.254)	(219.054)	(244.042)
c.t#c.flodarea1	-1,486.32	-1,192.548***	-541.024	-439.785	-636.432	-632.242	-835.623*	-934.094**	-1,239.794**	-1,448.258***
	(1,493.568)	(398.423)	(413.571)	(422.056)	(414.864)	(417.850)	(438.694)	(466.742)	(490.255)	(541.734)
Constant	-17,079.454***	-472.240***	-1,757.952***	-3,087.183***	-3,425.234***	-3,954.030***	-4,611.570***	-5,204.522***	-5,481.906***	-6,897.172***
	(2,634.886)	(179.527)	(241.024)	(256.094)	(251.720)	(246.883)	(247.229)	(253.484)	(258.708)	(276.704)
Observations	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390
R-squared	0.068	0.027	0.042	0.092	0.133	0.168	0.2	0.223	0.235	0.248

Table 12: Flood Effect on Total Household's Money Income (cont.)

VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	1,239.309***	1,447.310***	1,578.924***	1,842.871***	2,162.554***	2,644.234***	3,267.548***	3,901.613***	5,649.895***	6,492.830***
	(20.010)	(22.454)	(24.408)	(28.716)	(34.736)	(44.879)	(63.662)	(87.796)	(159.521)	(283.708)
malehead	-866.840***	-979.689***	-1,103.551***	-1,142.558***	-1,315.425***	-1,392.318***	-1,389.151**	-2,528.684***	-2,482.790*	-2,124.51
	(257.990)	(282.290)	(299.672)	(338.716)	(391.073)	(479.019)	(625.349)	(802.755)	(1,311.969)	(2,039.063)
headmarried	1,328.472***	1,312.204***	1,478.042***	1,286.974***	1,046.471***	565.458	226.79	351.409	-284.98	-909.92
	(261.580)	(286.149)	(303.385)	(343.333)	(397.384)	(482.294)	(623.103)	(790.008)	(1,314.006)	(2,064.575)
adultmale	4,185.651***	4,781.948***	4,825.763***	5,559.824***	5,894.378***	7,118.293***	8,551.235***	10,122.190***	14,146.749***	16,858.681***
	(153.634)	(171.622)	(184.338)	(211.631)	(246.094)	(306.507)	(407.982)	(553.226)	(962.238)	(1,732.754)
adultfem	4,710.407***	5,465.782***	5,592.435***	6,441.616***	7,254.604***	8,431.478***	10,123.128***	12,038.263***	16,502.679***	18,846.971***
	(157.240)	(175.709)	(197.367)	(225.291)	(263.311)	(326.906)	(430.141)	(562.309)	(961.173)	(1,641.400)
children03	-891.642***	-981.100***	-788.448**	-1,033.251***	-1,184.752***	-1,068.487*	-1,557.306**	-1,997.503**	-5,360.250***	-10,132.886***
	(286.983)	(320.202)	(344.749)	(393.064)	(450.368)	(561.252)	(721.587)	(931.232)	(1,494.938)	(2,156.605)
children415	288.290**	219.941	111.274	1.884	158.635	367.649	571.445	-533.522	-1,013.91	-2,794.150**
	(139.968)	(154.254)	(163.826)	(184.486)	(214.599)	(266.108)	(349.585)	(444.304)	(730.745)	(1,107.649)
adult60	2,295.111***	3,106.959***	3,613.271***	4,545.651***	5,792.090***	7,392.913***	9,561.745***	12,478.319***	19,059.324***	22,763.541***
	(154.829)	(170.767)	(181.777)	(206.759)	(239.523)	(294.656)	(394.758)	(524.571)	(916.932)	(1,579.068)
t	375.093	232.836	232.752	317.111	99.087	174.34	899.027	1,368.03	3,453.967**	7,347.375***
	(286.791)	(314.978)	(337.128)	(385.522)	(440.992)	(545.510)	(707.782)	(928.997)	(1,570.266)	(2,596.823)
flodarea1	1,422.754***	1,425.263***	1,319.974***	1,082.470***	463.698	-537.652	-1,066.46	-1,553.171*	-3,302.300**	-5,636.062***
	(271.273)	(304.137)	(322.971)	(370.529)	(429.922)	(526.729)	(675.388)	(860.884)	(1,365.175)	(2,055.344)
c.t#c.flodarea1	-1,144.186*	-1,374.835**	-1,753.561**	-1,300.02	-803.27	-1,849.092*	-3,786.939***	-3,740.769**	-7,293.960***	-8,113.003*
	(598.106)	(667.063)	(708.107)	(816.989)	(940.066)	(1,085.930)	(1,336.315)	(1,720.657)	(2,728.850)	(4,402.806)
Constant	-7,701.619***	-9,182.793***	-8,538.819***	-10,334.700***	-11,534.327***	-14,717.278***	-18,934.794***	-21,453.673***	-34,279.352***	-25,731.404***
	(294.794)	(313.514)	(339.690)	(376.459)	(437.207)	(539.865)	(716.871)	(971.079)	(1,756.762)	(3,114.636)
Observations	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390	31,390
R-squared	0.258	0.269	0.264	0.267	0.259	0.25	0.229	0.203	0.164	0.098

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

Table 13: Flood Effect on Total Household's Wage Income (Dependent variable is wage income)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	2,359.878***	271.919***	306.250***	386.188***	454.389***	491.493***	564.285***	635.820***	746.628***	871.967***
	(103.126)	(14.755)	(12.135)	(12.483)	(12.952)	(13.184)	(14.219)	(15.396)	(16.698)	(19.037)
malehead	-736.926	372.386*	385.295**	175.744	39.203	21.77	-26.979	-242.573	-146.328	-193.29
	(617.098)	(214.523)	(176.010)	(179.034)	(180.952)	(183.600)	(197.876)	(211.041)	(229.304)	(257.458)
headmarried	523.893	-445.714**	-260.392	-193.909	-40.688	152.736	157.136	282.236	528.858**	655.154**
	(670.571)	(214.693)	(177.640)	(181.905)	(183.701)	(187.210)	(200.894)	(213.638)	(233.032)	(261.171)
adultmale	5,192.941***	1,139.720***	1,113.496***	1,224.516***	1,335.206***	1,384.808***	1,620.073***	1,623.412***	1,830.271***	2,264.693***
	(573.647)	(109.109)	(91.726)	(97.610)	(100.547)	(102.287)	(112.062)	(124.942)	(136.085)	(152.365)
adultfem	5,359.297***	1,080.051***	967.501***	1,109.270***	1,284.577***	1,416.495***	1,577.282***	1,718.307***	2,100.395***	2,405.973***
	(612.470)	(104.905)	(86.196)	(90.572)	(95.819)	(97.635)	(107.529)	(132.415)	(143.691)	(161.426)
children03	-2,740.179***	11.556	-50.717	-245.765	-267.543	-403.046*	-391.907*	-405.362*	-579.974**	-801.234***
	(549.658)	(191.253)	(181.404)	(201.993)	(203.763)	(207.659)	(217.777)	(233.918)	(250.029)	(279.270)
children415	-918.554***	-141.193	-4.787	-131.878	-317.484***	-313.468***	-310.649***	-334.188***	-338.738***	-424.106***
	(310.027)	(115.394)	(88.637)	(93.919)	(99.381)	(100.855)	(107.950)	(114.512)	(123.782)	(137.809)
adult60	5,995.122***	-209.388	-77.612	180.432	257.744**	294.928**	443.794***	603.136***	920.436***	1,275.540***
	(624.530)	(142.765)	(113.190)	(115.868)	(117.540)	(119.460)	(127.407)	(133.597)	(143.112)	(159.541)
t	-658.603	-855.835***	-498.117**	-411.380*	-413.643*	-373.551*	-360.484	-284.876	-245.819	-353.796
	(660.760)	(277.736)	(205.782)	(212.715)	(214.556)	(217.068)	(228.234)	(242.026)	(261.572)	(293.959)
flodarea1	1,112.828*	1,086.745***	1,144.643***	1,414.623***	1,528.846***	1,559.578***	1,597.551***	1,733.952***	1,897.410***	2,122.511***
	(606.527)	(155.397)	(139.209)	(149.297)	(161.698)	(167.769)	(190.239)	(208.327)	(231.017)	(265.860)
c.t#c.flodarea1	158.263	543.711	264.851	126.522	-186.933	-248.912	-55.073	-465.367	-407.175	-556.326
	(1,771.881)	(411.643)	(331.321)	(353.929)	(388.768)	(401.532)	(432.870)	(470.271)	(518.305)	(598.469)
Constant	-13,660.258***	-1,855.801***	-599.139**	-962.998***	-1,093.324***	-717.815***	-802.801***	-858.840***	-1,956.990***	-2,996.180***
	(1,239.733)	(355.787)	(286.411)	(280.158)	(273.427)	(275.754)	(290.503)	(318.396)	(334.542)	(366.448)
Observations	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293
R-squared	0.255	0.062	0.096	0.116	0.139	0.151	0.164	0.17	0.191	0.202

Table 13: Flood Effect on Total Household's Wage Income (cont.)

VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	1,128.895***	1,274.785***	1,420.258***	1,631.073***	2,045.992***	2,310.346***	3,288.445***	4,035.355***	6,627.008***	9,565.937***
	(23.143)	(25.370)	(26.988)	(32.203)	(40.815)	(47.127)	(71.748)	(101.470)	(215.089)	(478.539)
malehead	-169.906	-226.309	-278.729	-175.983	-494.407	-419.067	-331.48	-2,094.373**	-3,115.072*	-2,286.78
	(312.314)	(332.634)	(347.973)	(388.613)	(473.554)	(519.248)	(732.017)	(948.145)	(1,815.705)	(3,461.169)
headmarried	845.441***	868.361***	1,261.105***	643.473*	800.040*	113.6	-129.63	363.309	-1,023.69	-388.769
	(316.600)	(334.035)	(346.042)	(386.346)	(471.982)	(518.688)	(733.767)	(947.479)	(1,848.406)	(3,597.894)
adultmale	2,951.771***	3,339.068***	3,312.543***	3,766.629***	4,399.786***	4,647.507***	5,985.892***	7,805.080***	11,827.516***	19,641.886***
	(184.700)	(201.172)	(210.845)	(235.675)	(291.484)	(326.862)	(473.986)	(654.576)	(1,349.485)	(3,102.017)
adultfem	3,192.167***	3,742.242***	3,966.880***	4,469.096***	5,286.477***	5,589.193***	7,434.637***	8,963.053***	14,404.545***	21,348.008***
	(195.545)	(211.778)	(223.139)	(250.331)	(310.040)	(346.242)	(500.254)	(652.196)	(1,283.388)	(2,739.193)
children03	-914.163***	-1,219.807***	-1,438.870***	-1,915.028***	-2,054.261***	-2,422.000***	-3,832.990***	-4,194.018***	-7,780.194***	-13,588.242***
	(339.904)	(370.043)	(385.522)	(424.635)	(515.134)	(544.808)	(740.140)	(934.066)	(1,666.703)	(3,212.438)
children415	-521.967***	-573.963***	-626.320***	-507.794**	-359.549	-174.989	-191.116	-1,206.279**	-3,125.020***	-5,364.226***
	(164.646)	(175.558)	(183.688)	(205.908)	(255.182)	(281.381)	(403.983)	(514.464)	(955.535)	(1,981.023)
adult60	1,976.689***	2,443.734***	2,896.184***	3,271.430***	4,342.638***	5,242.528***	7,799.290***	10,207.195***	17,270.207***	27,123.456***
	(192.470)	(207.146)	(218.984)	(253.695)	(311.561)	(343.755)	(493.709)	(656.480)	(1,311.378)	(2,822.208)
t	-488.228	-354.725	-233.379	-486.639	-717.047	-1,008.846*	-632.185	-560.219	593.63	-1,705.01
	(352.172)	(378.535)	(397.064)	(435.411)	(525.090)	(565.685)	(806.269)	(1,043.500)	(2,062.412)	(4,030.064)
flodarea1	2,732.406***	2,761.241***	2,530.639***	2,684.808***	2,643.344***	2,051.683***	1,656.580**	1,488.66	1,360.13	-4,460.33
	(329.445)	(360.364)	(376.303)	(426.896)	(531.630)	(587.189)	(839.176)	(1,080.707)	(2,060.267)	(3,723.203)
c.t#c.flodarea1	-1,406.372*	-1,182.31	-1,244.86	27.85	401.75	-1,955.34	-4,255.118***	-3,955.750*	-8,927.554**	-1,820.17
	(738.822)	(808.869)	(863.164)	(986.699)	(1,233.768)	(1,205.229)	(1,599.277)	(2,050.184)	(3,681.917)	(7,133.437)
Constant	-5,431.782***	-6,718.577***	-6,722.888***	-7,878.818***	-11,019.166***	-10,913.265***	-19,128.517***	-23,450.180***	-46,130.065***	-68,798.809***
	(427.623)	(449.173)	(465.329)	(516.398)	(632.636)	(697.078)	(1,003.632)	(1,363.986)	(2,781.331)	(6,122.757)
Observations	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293	16,293
R-squared	0.223	0.237	0.25	0.258	0.261	0.264	0.26	0.244	0.196	0.125

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

4.9. Effect of Flood on Household Income and Expenditure: Comparing 2009 and 2011

The simple tabulation in Figure 15-(a) shows that the real net farm income (or farm profit) in the 2011- flood year was substantially lower than that in 2009, by more than 60%. Although the result does not yet control for the changes in prices of agricultural products and cultivated land, it implies that the 2011 flood had a severe impact on the farmers in the Lower Northern and Central provinces along the Chao Phraya river basin. The households' business income also declined by less than 7 % between 2009 and 2011 (Figure 15-b).

Figure 16 compares the real income of households in 2009 and 2011 in two periods, i.e., a twelve month period, and the three months of October to December. In general the fourth quarter income of households in the flooded areas declined more than their annual income. The fourth quarter real income of households in 19 flooded provinces declined by 11.4 % between 2009 and 2011. Surprisingly, household income in 26 provinces also declined, and by a larger percentage, i.e., 12.8%, despite the fact that flood in the Northeast was not as severe as that in the Central Plains. On the other hand, the income of households in the non-flooded provinces increased between 2009 and 2011.

Except for the annual expenditure of households in the non-flooded areas, household expenditures of those in both the flooded and non-flooded areas declined between 2009 and 2011, implying that the 2011 flood had a widespread impact on household expenditure throughout the country. The monthly household expenditures of households in the 19 flooded provinces in the fourth quarter declined by a larger percentage than their average monthly expenditures over twelve months (Figure 17). The average 12-month expenditures of households in the non-flooded provinces in 2011 were slightly higher than that in 2009. But their fourth quarter monthly expenditures declined by almost 3 % between 2009 and 2011 (Figure 17).

The above tabulation does not control for other factors affecting real farm income. The researchers therefore use quantile regressions based on the "difference-in-difference" approach to estimate the effect of the 2011 flood on farm profits in 2011, using the households' farm profit in 2009 and 2011. The rationale is that most agricultural outputs are harvested during October and December of every year. Therefore, the full impact of a flood can be measured only when one has complete

information on annual farm income of the farm households in 2009 and can compare this with farm income in 2011. The results in Table 14 shows that the coefficients of the interaction between the time (flood period) and area (flooded areas) dummies are statistically significant with expected negative sign in only 6 regressions, i.e., 55th to 80th percentiles. The negative impact on farm profit of the middle income farmers is consistent with the estimated effect of floods on household expenditures of the middle income households. Another interesting variable is the flooded area dummy. The coefficients in all the regressions have the expected negative sign, but only nine out of 20 regressions are statistically significant. They are in the 5th to 45th percentiles (Table 14). The coefficients of time dummy (2011 equals 1) also have the expected negative sign in all regressions, but are statistically significant in 8 equations, i.e., from the 15th to the 75th percentile. The impact of floods on farm profit in 2011 relative to that in 2009 is calculated and shown in Figure 18.

Appendix Table A-2 also presents the estimates of flood impact on business profit in 2011 comparing to that in 2009. Although the results for all the flood variables have the expected negative sign, they are not significant, except the coefficient of interaction dummy (flooded area*flooded period) in two regressions.

Figure 15-a: Flood Impact on Net Farm Income in 2011 Relative to that in 2009

(Baht/month)

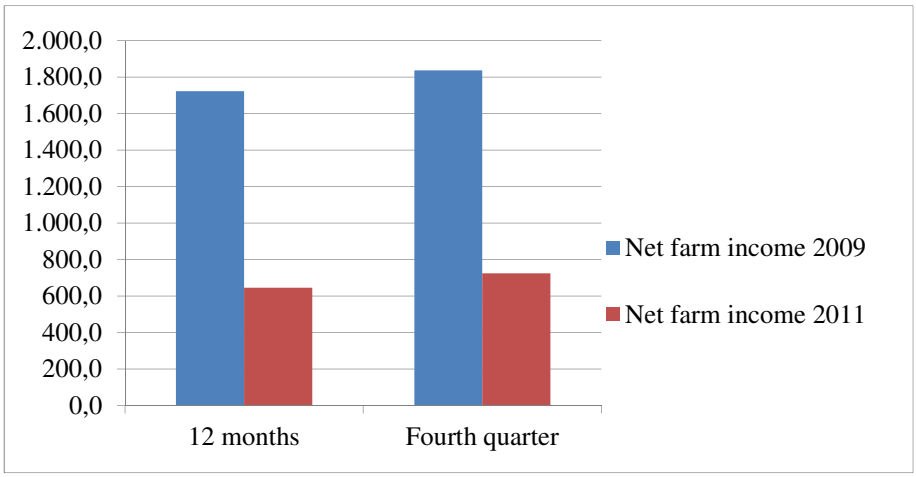
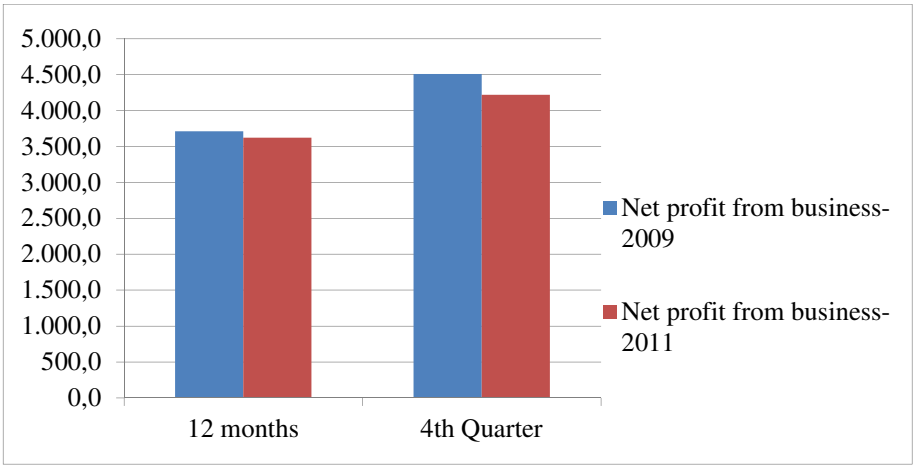


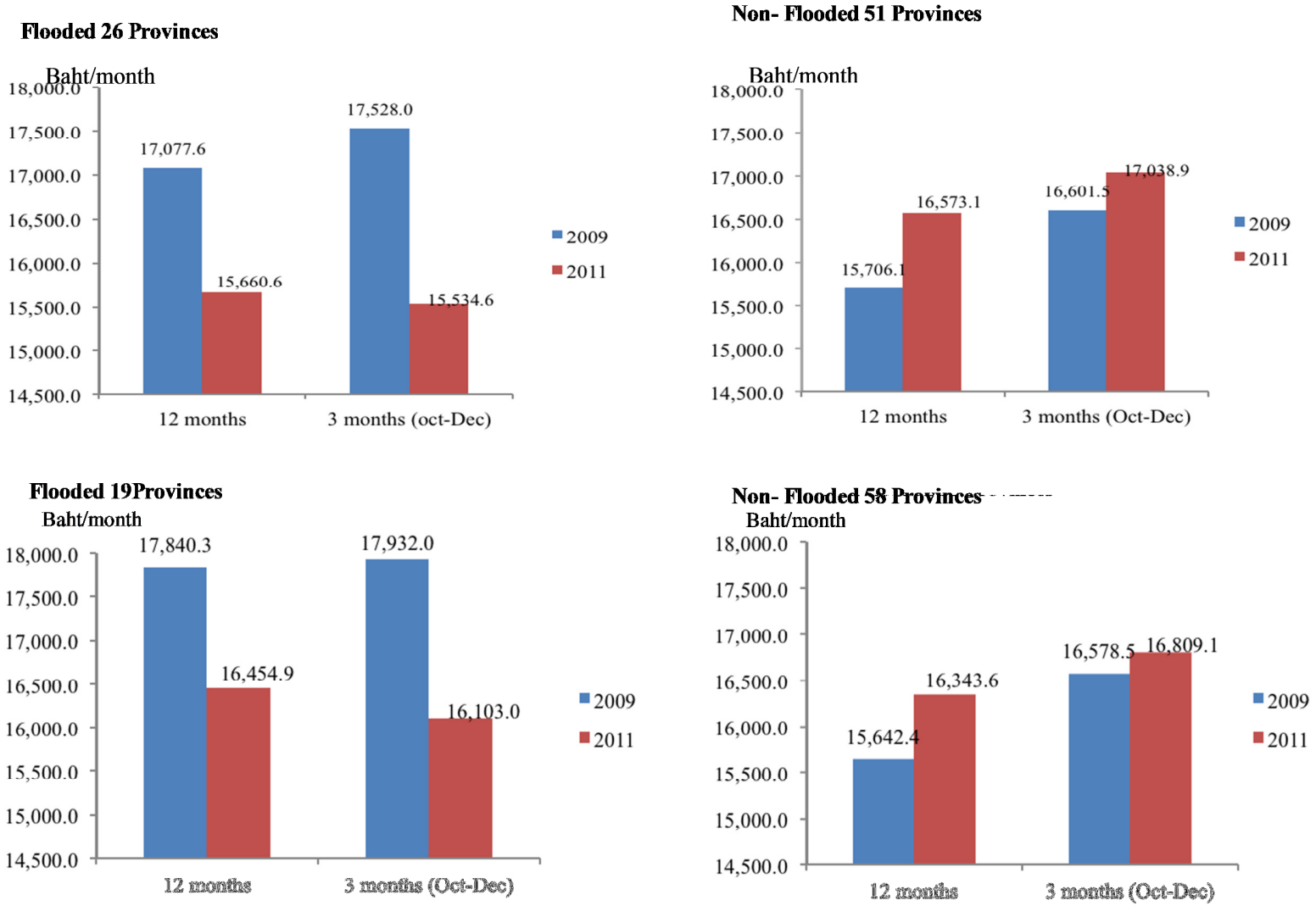
Figure 15-b: Flood Impact on Business Profit in 2011 Relative to that in 2009

(Baht/month)



Note: Baht 30.637 equal one USD.
Source: Calculated from NSO, SES 2009 and 2011.

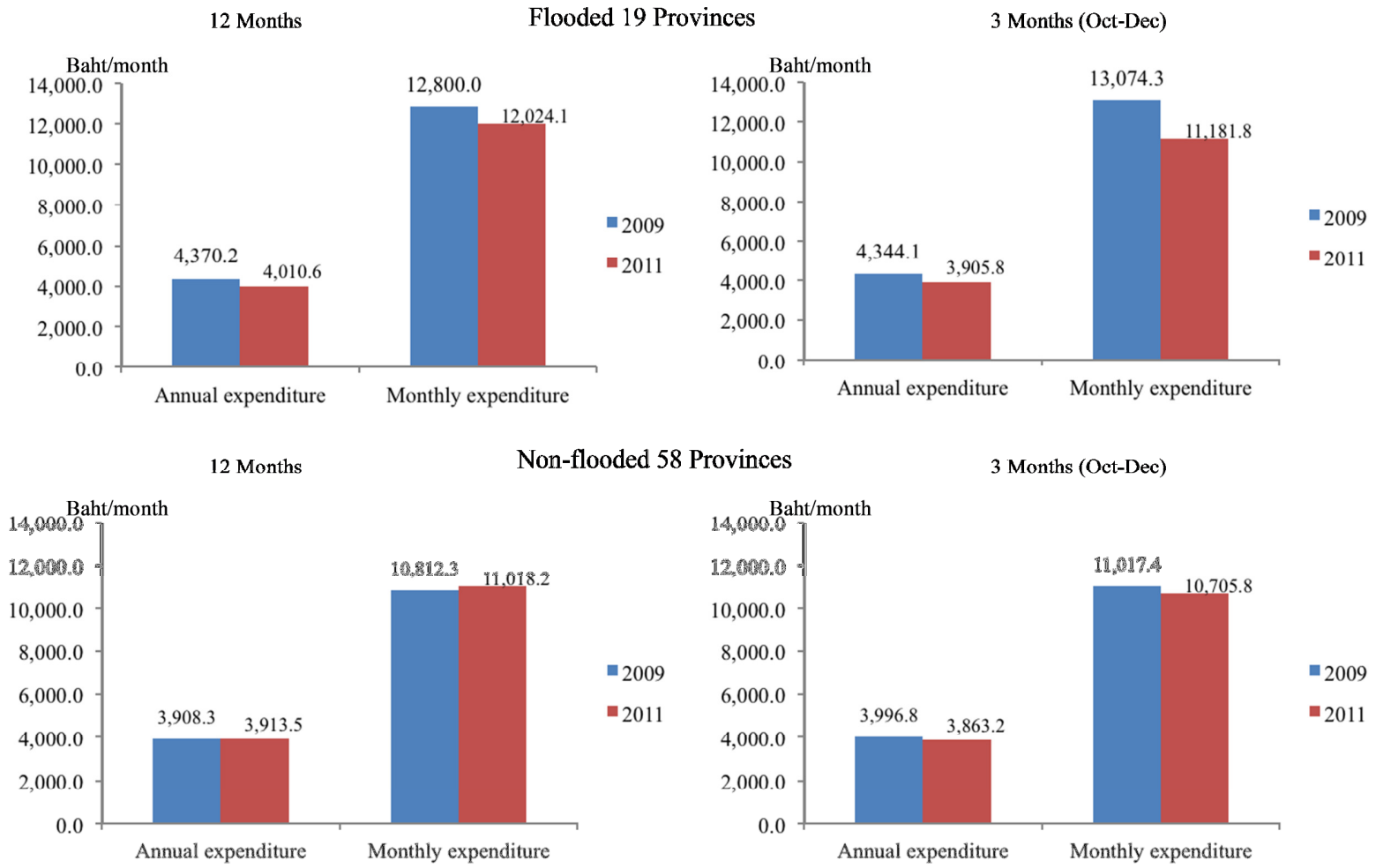
Figure 16: Real Income of Households in 2009 and 2011 (2007 = 100)



Note: Baht 30.637 equal one USD.

Source: Calculated from NSO, Socio-economic Survey, 2009 and 2011

Figure 17: Real Expenditure of Households in 2009 and 2011 (2007 = 100)



Note: Baht 30.637 equal one USD.
Source: Calculated from NSO, Socio-economic Survey,2009 and 2011.

Table 14: Flood Effect on Total Household's Farm Profit in 2009, 2011(Dependent variable is farm profit)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	1,264.915**	436.105*	46.057	81.373	159.105***	224.005***	329.927***	385.571***	397.658***	478.793***
	(605.208)	(228.080)	(67.507)	(58.531)	(60.157)	(67.293)	(72.100)	(74.414)	(80.530)	(92.894)
malehead	2,977.99	-4,065.650*	446.756	-124.111	488.987	1,676.344**	1,702.043**	1,672.424**	1,409.258*	1,748.992**
	(2,519.451)	(2,129.393)	(712.102)	(671.987)	(712.846)	(735.020)	(734.010)	(748.987)	(778.264)	(856.623)
headmarried	-1,817.06	2,499.34	-772.638	675.263	871.332	175.483	78.926	-61.724	-226.206	-315.247
	(3,268.974)	(2,914.557)	(789.427)	(801.197)	(821.075)	(807.822)	(793.174)	(811.967)	(845.517)	(950.367)
adultmale	-197.027	-1,389.87	-26.927	351.26	714.606**	617.130*	922.023***	1,050.130***	1,120.693***	1,243.165***
	(1,484.726)	(1,215.500)	(352.153)	(295.289)	(319.798)	(341.646)	(347.051)	(356.339)	(384.126)	(431.135)
adultfem	4,251.347**	-1,573.08	-0.001	516.193	352.195	965.132**	1,125.830***	1,255.584***	1,497.616***	1,595.872***
	(1,934.675)	(1,404.780)	(399.353)	(397.033)	(406.644)	(410.551)	(425.322)	(440.867)	(465.007)	(529.563)
children03	-2,095.78	-113.57	-191.284	307.204	501.498	-208.29	-815.976	-556.438	-642.781	-169.02
	(2,536.750)	(3,028.362)	(784.058)	(607.360)	(602.800)	(654.399)	(693.015)	(704.708)	(727.505)	(817.533)
children415	1,674.22	718.285	294.143	801.474***	1,197.882***	987.630***	638.958*	558.840*	744.562**	596.382
	(1,189.332)	(1,033.762)	(328.399)	(281.057)	(286.351)	(301.367)	(330.840)	(337.368)	(354.944)	(406.029)
adult60	1,900.95	-999.91	-570.393	-348.916	-316.727	-49.83	-28.735	90.717	327.011	310.843
	(1,731.965)	(1,412.726)	(413.125)	(377.925)	(377.736)	(384.663)	(395.750)	(405.071)	(428.130)	(481.814)
t	-1,678.93	701.405	237.884	1,252.864**	1,422.572**	2,232.755***	1,820.585***	2,408.661***	2,608.219***	2,647.215***
	(3,550.387)	(2,070.463)	(571.483)	(581.998)	(626.535)	(654.455)	(653.739)	(677.693)	(719.266)	(798.618)
flodarea1	-8,857.085*	-21,097.093**	-7,021.029***	-3,983.871**	-3,971.470**	-3,882.423**	-3,799.162***	-2,992.452**	-3,616.446***	-3,226.870**
	(5,065.984)	(10,017.855)	(2,243.694)	(1,736.352)	(1,688.745)	(1,509.448)	(1,417.530)	(1,424.224)	(1,394.089)	(1,501.769)
c.t#c.flodarea1	208.36	4,567.58	490.04	-1,255.79	-578.66	-465.85	-990.83	-2,478.94	-1,883.95	-2,187.93
	(6,094.346)	(11,303.364)	(2,653.337)	(2,059.501)	(1,982.608)	(1,817.660)	(1,720.391)	(1,719.575)	(1,701.610)	(1,836.080)
Constant	5,180.98	-3,141.55	358.23	-1,730.03	-2,933.309***	-4,213.689***	-3,845.599***	-3,852.676***	-3,723.597***	-3,622.720***
	(4,312.918)	(3,273.565)	(998.162)	(1,083.441)	(1,112.097)	(1,121.737)	(1,116.758)	(1,130.564)	(1,174.137)	(1,301.867)
Observations	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689
R-squared	0.029	0.04	0.06	0.065	0.079	0.09	0.098	0.11	0.105	0.098

Table 14: Flood Effect on Total Household's Farm Profit in 2009, 2011 (cont.)

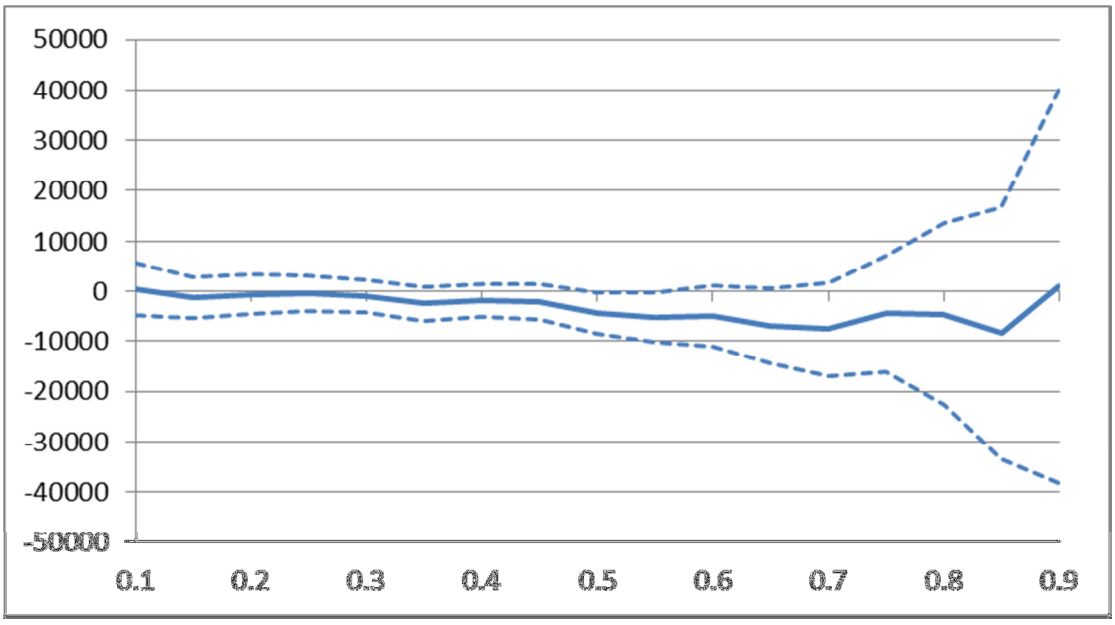
VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	614.699***	792.238***	1,082.802***	1,130.576***	1,354.177***	1,106.008**	1,189.69	1,225.34	2,829.78	3,328.97
	(111.293)	(144.579)	(193.485)	(256.622)	(336.097)	(452.288)	(747.172)	(1,057.739)	(1,770.621)	(2,523.388)
malehead	2,593.010***	3,996.051***	4,293.527***	3,973.182**	3,328.31	3,698.24	2,819.90	1,990.87	8,204.15	5,220.89
	(979.884)	(1,222.090)	(1,562.891)	(1,941.123)	(2,348.170)	(2,975.701)	(4,620.966)	(6,332.883)	(10,069.103)	(12,145.892)
headmarried	-403.318	-724.41	-655.037	204.53	1,088.79	1,882.43	3,797.40	794.16	-17,000.15	-15,842.16
	(1,090.617)	(1,356.204)	(1,741.028)	(2,172.328)	(2,665.948)	(3,399.883)	(5,176.986)	(7,325.842)	(12,656.446)	(15,998.476)
adultmale	1,310.876**	1,161.947*	1,155.87	1,428.00	2,306.254*	2,661.98	1,979.52	-1,702.35	-2,018.33	-5,637.32
	(515.658)	(657.687)	(862.738)	(1,065.002)	(1,355.734)	(1,788.574)	(2,621.847)	(3,006.478)	(4,512.428)	(5,836.926)
adultfem	1,958.517***	1,811.008**	2,391.643**	2,604.698**	2,335.27	4,351.610**	7,086.892**	7,859.243*	15,178.389**	18,221.667*
	(622.759)	(815.655)	(1,051.362)	(1,309.090)	(1,636.967)	(2,097.578)	(3,400.413)	(4,307.452)	(6,935.185)	(9,296.260)
children03	-597.991	-959.366	-2,404.07	-3,731.088**	-4,477.796*	-3,708.12	-7,718.504*	-6,817.37	-10,106.66	-2,618.92
	(950.677)	(1,199.917)	(1,523.531)	(1,846.616)	(2,286.080)	(2,942.638)	(4,520.705)	(5,981.098)	(9,378.844)	(12,045.688)
children415	675.595	1,455.673**	1,818.458**	1,702.945*	2,156.126*	3,363.202*	6,573.760**	7,456.937*	8,557.37	3,810.70
	(477.666)	(603.357)	(793.169)	(1,009.872)	(1,294.780)	(1,719.358)	(2,826.470)	(3,919.036)	(5,243.005)	(4,742.016)
adult60	584.711	811.462	952.254	650.588	847.06	844.98	558.95	-614.28	2,352.94	8,845.28
	(564.734)	(710.859)	(934.665)	(1,155.533)	(1,462.248)	(1,835.250)	(2,833.580)	(3,894.604)	(6,094.767)	(8,234.038)
t	3,454.003***	4,137.008***	4,882.607***	5,655.532***	5,915.280**	3,919.82	3,232.54	2,301.43	-4,020.70	-18,561.87
	(935.478)	(1,185.755)	(1,548.059)	(1,922.823)	(2,446.310)	(3,209.193)	(5,103.727)	(6,970.535)	(11,228.551)	(15,344.416)
flodarea1	-2,771.01	-2,715.23	-3,218.12	-2,139.93	-2,500.20	-6,189.31	-7,942.07	-3,258.62	-11,633.74	-6,777.68
	(1,718.691)	(2,102.178)	(2,590.264)	(3,213.371)	(4,050.799)	(4,821.884)	(7,598.690)	(10,681.557)	(16,494.296)	(22,860.246)
c.t#c.flodarea1	-4,373.674**	-5,134.246**	-5,062.05	-6,922.886*	-7,643.52	-4,514.00	-4,611.16	-8,340.34	960.17	14,719.43
	(2,056.134)	(2,515.438)	(3,118.586)	(3,856.616)	(4,831.085)	(5,865.569)	(9,276.700)	(12,796.969)	(19,982.814)	(28,282.853)
Constant	-4,693.931***	-5,548.246***	-6,731.189***	-5,845.011**	-4,994.02	-2,797.41	-1,316.78	13,754.21	24,278.02	50,739.712**
	(1,486.848)	(1,844.161)	(2,388.509)	(2,951.684)	(3,735.755)	(4,767.591)	(7,467.826)	(10,074.274)	(15,796.039)	(21,546.685)
Observations	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689
R-squared	0.111	0.105	0.096	0.076	0.065	0.047	0.037	0.021	0.022	0.019

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

Figure 18: Flood Effect on Farm Profit in 2011 Relative to that in 2009

(Baht/month)



Source: Calculated from Table 14.

5. Conclusion and Policy Implications

The objectives of this study are threefold: to describe the causes of Thailand's 2011 flood, and the government's response; to revise the World Bank's estimated agricultural loss; and to estimate the impact of the 2011 flood on household expenditure and income, using the "difference-in-difference" method.

The 2011 flood -the biggest and worst flood in Thailand's modern history- resulted in total damage and loss of USD46.5 billion. It was caused by the highest recorded rainfall, including 5 tropical storms which were concentrated in a short period of 106 days in the mid rainy season. But man-made mistakes worsened the situation, particularly the unregulated changes in land-use pattern and flood mismanagement. Political pressure has forced the government to allocate USD 11.29 billion for assistance of, and compensation to flood victims, restoration of damaged property, and flood management action plans, under a comprehensive flood management master plan, all of which were drafted in relatively few months following the flood.

This paper revises the World Bank's estimates of agricultural loss, using satellite radar images which allow researchers to identify districts (and sub-districts or "tambons") that were flooded for at least two consecutive weeks. The revised estimates of loss are lower than those of the World Bank. This is because the World Bank estimates were based solely on the size of farm lands that were flooded, without taking into account the flood's duration. Using the two-week duration of flood from the satellite images, the study also argues that the MOAC reported loss of agricultural output might be too high, thanks to the moral hazard of farmers' self-reports that were filed for compensation from the government. Compensation for farmers accounted for most (49%) of the government compensation for households. But our estimates also suffer from the problem of outdated information on agricultural land use, which recently has rapidly been taken up by non-agricultural uses, particularly in some rapidly developed provinces.

Finally, the study develops the "difference-in difference" method to estimate the impact of the flood on expenditure and income of households in 26 flooded provinces. Since the 2011 Socio-economic Survey did not contain questions regarding the impact of floods, the researchers have had to identify households that were affected by the flood in the fourth quarter of 2011. Thanks to the satellite radar images, the households in the flooded sub-districts (tambons) can be matched with the flooded areas in the satellite images. The estimated results confirm that the 2011 flood had a significant negative impact on expenditures of not only households in the flooded provinces but also those in non-flooded areas, indicating the inter-dependence between families in the flooded areas and those in non-flooded areas. One explanation is that the 2011 flood seriously affected Bangkok and its vicinity, which are the main economic activity zones of the country, where workers from every province come to work. When their income declined significantly, their families in the non-flooded areas received smaller repatriation income and thus had to reduce their expenditures. The study also finds that the 2011 flood had a negative impact on money income and wage income of households in the flooded areas. The results for business income are not statistically significant. Using the Socio-economic Survey in 2009 and 2011, the study also finds that the 2011 flood had a large negative impact on the farm profits of households in the flooded provinces.

One interesting finding is that the 2011 flood had relatively more impact on the expenditures and incomes of middle income households than other income classes,

thus explaining why the government paid billions of baht for compensation, has been very active in formulating the flood management master plan, and plans to spend more almost $17 billion in the coming years.

Finally, the study finds several weaknesses in the current information for flood management. (a) Despite the huge volume of information on the impact of flooding on output and damage to property, as reported by millions of flooded citizens, no government agency has paid attention to computerizing the flood data-base and information system and strengthening the capability of their information centers. As a result, valuable individual data have been discarded and were not brought into use for the policy making process.

(b) GISTDA still lacks some crucial information on flooding that will allow users to measure the true impact of a flood. Two important areas need to be urgently implemented. These are the construction of a digital elevation map, and investment in ground truthing activities to validate the information from satellite images. Some of the most important information urgently needed includes updated land-use patterns and the digitization of village boundaries. There is additionally a need to explore the possibility of using new techniques to identify and measure flooding in the cities.

The following are some policy recommendations. First, the capability of statistical agencies and agencies that are responsible for flood management should be urgently strengthened in the following areas: data collection, data base development, data processing and reporting using IT, and human resource development. Secondly, these agencies should be encouraged to communicate and exchange information and ideas with data users.

References

Bangkok biznews (2011), 'Mismanagement-Wrong Decision, Great Flood Resulted From Politics',(in Thai) *Bangkokbiznews*, 8th Nov. 2011. N.p Available at: http://www.bangkokbiznews.com/home/detail/politics/analysis/20111108/418193/บริหารผิด-ตัดสินใจพลาด...น้ำท่วมใหญ่จากการเมืองล้วนๆ.html (accessed June 29, 2012).

Department of Disaster Prevention and Mitigation, Ministry of Interior (DDPM) (2011), *Report on Flood in 2011*. January 2012.

Electricity Generating Authority of Thailand (EGAT) (Various years) *Data on Irrigated Water Management at Major Dams*.

EGAT (2012), 'Fact: Water Drainage Management of Bhumibol and Sirikit Dams', (in Thai) *Power Purchase Agreement Division*. EGAT, n.d. Available at: http://www.ppa.egat.co.th/Pr-Egat/2554/1-11-54Water-drain-fact/waterdrain-factข้อเท็จจริงการระบายน้ำของเขื่อนภูมิพลและเขื่อนสิริกิติ์.htm (accessed June 29, 2012).

Firpo, S., N. Fortin and T. Lemieux (2009), 'Unconditional Quantile Regression', *Econometrica* 77(3), pp.953-973.

GISTDA (2011), *Radar Satellite Images and Flood Maps of the 2011 Flood*, May-December 2011.

Komchadluek (2011), 'Banhan Criticizes Scholars, Says Prime Minister Pass The Test', (in Thai) *Komchadluek Online*. N.p., n.d. Available at: http://www.komchadluek.net/detail/20111105/114095/บรรหารเฉ่งนักวิชาการให้ปูสอบผ่าน.html (accessed June 29, 2012).

Ministry of Agriculture and Cooperatives (2011), *Report on Impact of Flood on Farmers*, May-December 2011.

Royal Irrigation Department (RID) (Various years), *Information on the Irrigated Water Management at Major Sluice Gates and Canals.*

Suppaisarn, C. (2008), 'Land Management and Flood Plain Development Project for Chao Phraya Basin's Flood Relief Following HM the King's Monkey Cheek Concept at Bang Ban', *Manual of Development Project: Process and Maintenance of Monkey Cheek Reservoirs at Bang Ban* 5.

Suppaisarn, C. (2011) '*Medium and Heavy Flood Management in Chao Phraya River Basin Following the Royal Initiative'*. TRF Seminar, 2 Dec. 2011.

Strategic Committee for Water Resource Management, Office of the Strategic Committee for Water Resource Management, and Office of the National Economic and Social Development Board (2012), *Master Plan on Water Resource Management*. Rep. Bangkok: n.p., Jan, 2012.

Takeya, K. (2012), *JICA's Support to Toward Safe & Resilient Thailand" through Revising the Comprehensive Flood Management Plan for the Chao Phraya River Basin*. Rep. N.p.: JICA, 2012.

Thairath (2011), 'Chainart Locals Furious, Banhan Protects Suphanburi', (in Thai) *Thairath Online*. 24th Sept. 2011. N.p. Available at: http://www.thairath.co.th/content/region/204220 (accessed June 29, 2012).

Tobunmee, W. (2012), 'Review Lesson of 2011 Flood: Look Forward to The Future', *Dailynews* [Bangkok] 25 Jan.

World Bank (2012), *Thai Flood 2011. Rapid Assessment for Resilient Recovery and Reconstruction Planning*. Bangkok: The World Bank.

.

Appendix

Table A-1: Flood Effect on Total Household's Business Profit in 2009, 2011 (Dependent variable is household's business profit)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45
headsch	1,393.003***	96.554***	112.587***	158.260***	159.967***	214.073***	233.358***	279.959***	328.499***	410.923***
	(220.479)	(28.524)	(32.729)	(34.294)	(36.083)	(38.592)	(41.143)	(42.439)	(45.255)	(48.991)
malehead	-466.43	401.141	341.557	263.332	332.082	273.182	583.257	36.789	210.423	60.258
	(2,695.472)	(495.827)	(472.146)	(462.244)	(451.652)	(457.633)	(470.047)	(487.735)	(511.974)	(550.582)
headmarried	4,982.308*	-229.057	342.489	33.97	579.38	664.176	801.139	1,365.318**	1,675.672***	1,507.781**
	(2,767.904)	(483.583)	(491.658)	(486.759)	(487.945)	(494.153)	(505.011)	(530.574)	(554.677)	(589.900)
adultmale	3,150.567***	232.495	400.255**	523.980***	673.105***	704.179***	646.160***	834.367***	922.150***	1,042.665***
	(1,171.139)	(200.398)	(202.095)	(198.456)	(198.386)	(214.050)	(235.348)	(249.878)	(270.507)	(298.232)
adultfem	1,212.35	856.572***	804.651***	1,034.425***	1,051.828***	1,101.294***	959.472***	1,000.019***	1,256.463***	1,091.528***
	(1,813.278)	(234.485)	(224.741)	(219.894)	(218.872)	(226.999)	(244.354)	(258.913)	(274.264)	(301.860)
children03	-2,293.42	-588.226	-590.008	-567.937	-743.856*	-562.378	-456.313	-323.145	-716.804	-527.468
	(1,653.711)	(443.706)	(438.099)	(423.248)	(429.574)	(444.349)	(463.494)	(481.583)	(533.205)	(579.760)
children415	-327.389	-133.631	-195.797	-166.516	-321.298	-294.42	-173.761	-201.758	-177.281	-120.049
	(1,169.230)	(201.966)	(188.607)	(215.514)	(214.971)	(230.055)	(232.719)	(242.525)	(257.769)	(275.761)
adult60	2,538.87	-836.941***	-946.892***	-968.932***	-1,015.096***	-887.239***	-1,026.494***	-791.996**	-585.856*	-676.940*
	(1,724.363)	(241.441)	(256.941)	(267.638)	(270.557)	(279.246)	(298.664)	(309.979)	(328.202)	(357.019)
t	-334.652	-587.811*	-349.834	-752.719**	-216.584	-126.964	-822.686**	-889.940**	-963.675**	-685.551
	(1,782.536)	(351.483)	(360.695)	(361.484)	(377.729)	(399.277)	(417.182)	(433.497)	(463.485)	(505.479)
flodarea1	1,902.13	257.223	247.335	158.399	722.684	929.343*	807.57	388.093	831.207	1,573.028**
	(2,651.200)	(327.738)	(410.098)	(430.666)	(445.194)	(477.532)	(505.588)	(557.337)	(605.256)	(672.918)
c.t#c.flodarea1	3,573.67	576.132	472.09	923.276	-20.301	-734.463	-235.694	-270.709	-506.447	-1,768.304*
	(7,241.631)	(591.768)	(641.411)	(677.735)	(693.276)	(742.796)	(775.165)	(849.524)	(901.281)	(987.828)
Constant	-666.78	110.173	542.186	1,261.936**	1,447.223**	1,542.596**	2,476.164***	2,754.488***	2,744.561***	3,165.717***
	(2,807.874)	(637.768)	(662.863)	(625.446)	(651.071)	(686.650)	(722.151)	(738.444)	(779.206)	(834.950)
Observations	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113
R-squared	0.015	0.036	0.041	0.053	0.058	0.06	0.065	0.068	0.075	0.076

Table A-1: Flood Effect on Total Household's Business Profit in 2009, 2011 (cont.)

VARIABLES	rif50	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	492.898***	647.323***	767.467***	836.493***	847.724***	1,120.722***	1,219.233***	1,552.926***	2,228.049***	6,137.706***
	(52.113)	(62.890)	(75.852)	(82.034)	(89.780)	(127.664)	(145.741)	(181.335)	(317.096)	(1,023.550)
malehead	280.385	513.896	853.053	101.345	-299.708	-311.83	-106.56	-478.75	-1,174.42	-6,617.25
	(576.822)	(683.839)	(801.506)	(838.931)	(907.119)	(1,255.317)	(1,403.849)	(1,701.840)	(2,800.549)	(8,643.603)
headmarried	1,385.944**	2,142.999***	2,525.807***	3,320.821***	3,322.135***	3,425.072***	3,128.824**	3,275.326**	3,226.38	15,564.040**
	(616.188)	(718.612)	(837.148)	(855.039)	(920.547)	(1,267.065)	(1,418.540)	(1,635.598)	(2,684.213)	(7,883.914)
adultmale	1,541.421***	1,906.198***	2,389.268***	2,317.403***	2,401.784***	3,306.422***	3,326.970***	4,621.746***	6,275.712***	17,073.464***
	(315.739)	(377.525)	(447.980)	(481.845)	(535.343)	(768.075)	(898.710)	(1,182.378)	(2,023.268)	(5,355.287)
adultfem	1,174.705***	1,491.900***	1,946.428***	2,178.605***	2,478.758***	3,884.892***	4,257.461***	4,637.939***	7,577.311***	7,710.07
	(315.230)	(378.621)	(450.781)	(482.308)	(533.848)	(764.605)	(906.857)	(1,235.911)	(2,279.645)	(5,391.501)
children03	-487.663	-977.834	-1,180.72	-1,491.16	-1,232.39	-1,193.50	-703.728	810.358	-153.46	-1,655.09
	(625.856)	(748.555)	(895.388)	(963.704)	(1,051.955)	(1,498.834)	(1,683.314)	(2,110.520)	(3,704.825)	(9,763.440)
children415	-221.298	-218.374	-182.074	-121.597	135.706	5.204	-69.624	-282.775	552.024	1,471.89
	(287.659)	(343.521)	(403.497)	(427.478)	(468.562)	(652.362)	(718.177)	(902.182)	(1,547.062)	(4,754.876)
adult60	-644.434*	-865.132**	-688.765	-411.248	-199.297	31.959	983.313	2,792.282**	5,364.513***	13,000.359**
	(371.720)	(440.862)	(505.931)	(516.745)	(557.242)	(767.535)	(869.825)	(1,099.775)	(1,897.524)	(6,217.280)
t	-1,235.387**	-1,150.172*	-1,156.29	-1,292.56	-1,502.642*	-2,727.027**	-2,935.288**	-1,247.21	557.191	3,673.65
	(536.459)	(639.768)	(758.896)	(796.541)	(862.446)	(1,218.597)	(1,374.824)	(1,675.460)	(2,780.541)	(7,989.081)
flodarea1	1,447.637*	2,458.470***	2,953.804***	3,119.355***	2,693.991**	2,614.51	2,742.97	5,438.703*	3,917.11	7,010.19
	(741.757)	(899.301)	(1,110.324)	(1,209.761)	(1,361.146)	(1,934.879)	(2,229.982)	(2,815.213)	(4,550.012)	(13,655.054)
c.t#c.flodarea1	-856.594	-1,923.25	-2,040.01	-2,319.60	-2,184.03	-1,950.72	-1,425.80	-5,690.02	-5,022.89	-7,692.92
	(1,068.079)	(1,284.049)	(1,547.880)	(1,650.949)	(1,802.827)	(2,521.776)	(2,883.149)	(3,584.924)	(6,016.096)	(18,349.805)
Constant	2,783.425***	1,653.731*	728.432	1,720.74	2,496.085**	1,664.65	3,106.90	573.49	-4,509.51	-36,767.987***
	(847.511)	(984.938)	(1,142.022)	(1,176.071)	(1,251.404)	(1,768.860)	(1,989.470)	(2,402.659)	(4,188.466)	(11,648.178)
Observations	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113	4,113
R-squared	0.094	0.109	0.11	0.108	0.098	0.091	0.08	0.075	0.052	0.037

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated from NSO, Socio-economic Survey, 2011.

Appendix A-2: Regressions of Business Profits in 2009, 2011 (Dependent variable is household's business profit)

VARIABLES	OLS	rif5	rif10	rif15	rif20	rif25	rif30	rif35	rif40	rif45	rif50
headsch	1,444.767***	95.149***	138.896***	126.397***	218.618***	279.800***	323.968***	386.109***	476.515***	547.685***	677.759***
	-242.488	-31.081	-33.073	-34.115	-38.965	-40.576	-42.829	-45.528	-49.617	-55.032	-63.796
malehead	109.744	-210.653	-8.281	127.592	-337.168	-216.275	-160.995	-255.845	39.072	84.616	397.791
	-3,081.84	-377.776	-426.414	-409.155	-417.168	-443.641	-481.435	-519.639	-563.663	-624.521	-715.588
headmarried	5,320.392*	148.406	481.416	808.574*	833.764*	811.702*	1,384.226***	1,798.655***	1,929.581***	1,655.899**	2,290.510***
	-3,075.48	-362.768	-452.375	-452.591	-454.594	-481.387	-520.436	-556.965	-591.852	-649.969	-740.788
adultmale	2,897.262**	435.592**	506.640**	501.505**	806.544***	701.582***	585.716**	567.699**	737.160**	1,240.359***	1,225.860***
	-1,449.61	-216.105	-203.109	-199.896	-208.506	-224.075	-261.333	-284.392	-311.358	-344.393	-393.567
adultfem	*3,192.643***	*447.257**	*720.745****	*828.325****	*837.407****	*1,053.406****	*1,143.801****	*1,482.319****	*1,690.815****	*1,613.355****	*1,937.648****
	-1,393.87	-231.532	-218.922	-219.622	-226.869	-240.666	-260.341	-279.467	-310.395	-347.186	-400.283
children03	-1,847.76	-742.336	-248.959	-247.052	-83.967	-178.096	-62.563	-173.061	-44.98	-90.187	-693.078
	-2,011.13	-565.659	-457.08	-437.886	-443.342	-481.394	-507.917	-552.802	-616.543	-700.352	-800.91
children415	400.427	11.415	-56.008	-331.042*	-485.137**	-350.476	-347.341	-221.434	-582.233**	-369.139	-363.681
	-1,446.66	-187.093	-192.492	-199.856	-209.879	-237.455	-248.554	-269.675	-288.27	-321.046	-366.829
adult60	4,999.068***	-1,018.313***	-1,129.085***	-1,253.238***	-764.232**	-796.905***	-942.865***	-755.381**	-803.471**	-534.183	-915.871*
	-1,867.83	-294.32	-300.463	-292.558	-297.732	-308.406	-331.936	-352.281	-387.704	-422.293	-479.862
t	2,411.08	142.176	78.118	606.771	126.382	-182.443	-281.876	-648.987	-597.425	-173.562	-161.376
	-2,226.60	-397.699	-393.383	-385.559	-409.429	-431.03	-456.501	-485.401	-524.466	-576.015	-660.968
flod2wk	-701.64	-47.139	-396.923	-50.272	-387.455	-190.939	-642.404	-1,050.75	-492.931	-554.655	56.489
	-2,969.35	-516.066	-566.554	-547.469	-573.619	-587.031	-642.85	-699.084	-755.463	-847.007	-975.127
c.t#c.flod2wk*	-306.34	639.422	1,003.75	579.54	875.799	992.50	1,516.387*	1,778.884*	865.86	933.92	151.67
	-4,372.32	-697.728	-768.429	-744.966	-810.968	-845.806	-901.454	-1,040.24	-1,114.39	-1,245.36	-1,436.85
Constant	-5,057.672*	486.062	608.619	1,329.382**	1,480.790**	1,672.629**	1,961.682***	1,877.322**	1,656.720*	1,299.92	877
	-3,039.78	-587.809	-635.282	-627.645	-650.368	-715.297	-758.308	-805.26	-862.324	-930.50	-1,055.91
Observations	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806
R-squared	0.017	0.028	0.044	0.052	0.053	0.062	0.072	0.081	0.097	0.094	0.107

Note: * c.t#c.flod2wk is an interaction dummy variable between t and flod2wk.
Source: Calculated from NSO, SES 2011

Appendix A-2: Regressions of Business Profits in 2009, 2011 (cont.)

VARIABLES	rif55	rif60	rif65	rif70	rif75	rif80	rif85	rif90	rif95
headsch	822.857***	874.206***	943.872***	1,077.997***	1,040.973***	1,110.912***	1,682.416***	2,747.259***	11,978.189***
	-74.411	-82.93	-91.989	-119.877	-128.558	-141.147	-218.485	-388.809	-2,173.09
malehead	610.24	331.835	-385.878	587.58	905.20	1,595.38	2,233.63	883.00	-8,957.93
	-826.433	-894.181	-985.479	-1,244.91	-1,304.20	-1,434.47	-2,161.45	-3,625.39	-19,182.49
headmarried	2,671.781***	3,384.688***	3,370.647***	3,181.828**	3,823.113***	3,143.404**	4,211.667**	5,877.261*	38,470.915**
	-851.496	-902.848	-988.012	-1,246.66	-1,287.66	-1,412.61	-2,012.62	-3,282.59	-16,693.57
adultmale	1,667.278***	1,822.067***	1,909.273***	2,755.858***	1,889.679**	2,663.755***	3,460.546**	3,315.40	27,504.179**
	-449.799	-505.493	-565.312	-737.515	-787.793	-895.289	-1,454.11	-2,140.73	-10,735.29
adultfem	2,431.849***	2,932.047***	3,219.124***	4,013.541***	4,935.102***	4,992.175***	6,977.535***	11,455.305***	14,475.08
	-463.208	-510.207	-574.574	-747.253	-801.053	-937.13	-1,569.65	-2,923.15	-11,259.58
children03	-968.551	-1,237.04	-1,177.48	-1,749.27	-905.36	59.00	349.71	-1,183.86	11,883.67
	-935.088	-1,042.98	-1,146.41	-1,478.83	-1,582.20	-1,777.81	-2,601.31	-4,553.21	-22,526.63
children415	-266.5	-148.898	116.949	-63.512	1.873	-304.34	-338.561	-150.84	9,215.69
	-417.844	-461.25	-513.513	-662.698	-686.637	-753.72	-1,192.47	-2,000.35	-11,012.19
adult60	-762.08	-401.477	70.187	133.382	1,059.30	1,956.034**	3,490.323**	6,284.936**	40,211.567***
	-528.932	-555.671	-610.675	-789.448	-844.195	-948.801	-1,472.58	-2,544.96	-15,231.41
t	-559.30	298.66	216.54	-209.847	-1,205.32	-530.46	1,542.83	4,042.96	20,281.28
	-755.673	-818.01	-892.523	-1,147.20	-1,211.77	-1,348.16	-2,071.39	-3,532.93	-19,060.74
flod2wk	208.037	566.063	454.194	-610.21	-1,922.24	-945.46	38.475	-2,292.76	-20,429.22
	-1,142.50	-1,246.86	-1,368.56	-1,722.99	-1,721.56	-1,897.64	-2,930.45	-4,668.99	-21,201.43
c.t#c.flod2wk	633.94	563.51	-899.39	365.33	2,549.83	1,143.83	-1,527.62	-3,814.17	-11,811.09
	-1,677.88	-1,842.91	-1,987.84	-2,518.45	-2,589.05	-2,749.02	-4,199.03	-6,225.76	-29,220.95
Constant	-63.00	-579.18	-148.87	-336.33	1,638.91	2,454.86	-3,629.61	-11,854.070**	-133,574.365***
	-1,168.19	-1,222.94	-1,315.35	-1,688.54	-1,765.70	-1,982.03	-2,974.03	-5,360.82	-26,470.71
Observations	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806	3,806
R-squared	0.117	0.115	0.105	0.094	0.087	0.082	0.073	0.063	0.044

Note: * c.t#c.flod2wk is an interaction dummy variable between t and flod2wk.
Source: Calculated from NSO, Socio-economic Survey 2011.

ENDNOTES

[1] The previous biggest flood in Bangkok occurred in 1942. Based on the current river discharge, the World Bank (2012) estimates that the 2011 flood is a 1 in 50-100 year event. The total rain for July to September was about 1,156 mm- the highest amount of rain recorded since record keeping began in 1901.

[2] At first the authors planned to revise the estimate of agricultural damage using the survey of famers who borrow from the Bank for Agriculture and Agricultural Cooperatives (BAAC). Unfortunately BAAC did not digitize the detailed data on damaged assets and farm machinery into its computer system.

[3] Since the flood-prone areas can grow only low yield floating rice, the land price is low. Other reasons why the estates are located in Ayuthaya, which is less than 50 km from Bangkok, are policy distortions, i.e., the factories there were entitled to higher tax "holidays" and lower minimum wages than those in Bangkok.

[4] At least there were ten major dyke breaches and damage to the flood control infrastructure in the Chao Phraya River basin between 14 September and 3 October 2011 (Royal Irrigation Department).

[5] Rule curve is the optimum operation rules for reservoir systems with multiple purposes. The rules involve non-linear and complex mathematical relations among hydropower plant's efficiency, flow rate, reservoir water level, and storage.

[6] This explains why only 35,018-64,458 rais of farm land in Supanburi were reported to be damaged, despite the fact that 975,756 rais were flooded according to the satellite images from GISTDA.

[7] The term 'Monkey Cheek' was coined by King Bhumibol of Thailand as a metaphor to promote local water retention systems. It refers to monkeys filling up their cheeks with excess food. The food is stored and chewed and eaten later. The monkey cheek program was initially started to solve the flood problems in Bangkok, bur has subsequently been replicated all over the country. (http://www.thewaterchannel.tv).

[8] It should be noted that during the 2011-flood, GISTDA provided every government agency with flood maps. Whether or not they were used in their reports is not clear.

[9] Although the Socio-economic Survey allows us to identify the villages in which the households live, the researchers cannot identify the village boundary from the satellite images due to the lack of official digitalized data on village boundaries.

[10] The researchers dropped the plan to use the 2-week flood period for two reasons. First, there are problems of estimating the areas that were flooded for more than 14 days from the satellite data. Secondly, in reality the flood not only had an impact on expenditures of households that were flooded for a long time, but also on those that were flooded for a short period.

ERIA Discussion Paper Series

No.	Author(s)	Title	Year
2013-34	Nipon POAPONSAKORN and Pitsom MEETHOM	Impact of the 2011 Floods, and Food Management in Thailand	Nov 2013
2013-33	Mitsuyo ANDO	Development and Resructuring of Regional Production/Distribution Networks in East Asia	Nov 2013
2013-32	Mitsuyo ANDO and Fukunari KIMURA	Evolution of Machinery Production Networks: Linkage of North America with East Asia?	Nov 2013
2013-31	Mitsuyo ANDO and Fukunari KIMURA	What are the Opportunities and Challenges for ASEAN?	Nov 2013
2013-30	Simon PEETMAN	Standards Harmonisation in ASEAN: Progress, Challenges and Moving Beyond 2015	Nov 2013
2013-29	Jonathan KOH and Andrea Feldman MOWERMAN	Towards a Truly Seamless Single Windows and Trade Facilitation Regime in ASEAN Beyond 2015	Nov 2013
2013-28	Rajah RASIAH	Stimulating Innovation in ASEAN Institutional Support, R&D Activity and Intelletual Property Rights	Nov 2013
2013-27	Maria Monica WIHARDJA	Financial Integration Challenges in ASEAN beyond 2015	Nov 2013
2013-26	Tomohiro MACHIKITA and Yasushi UEKI	Who Disseminates Technology to Whom, How, and Why: Evidence from Buyer-Seller Business Networks	Nov 2013
2013-25	Fukunari KIMURA	Reconstructing the Concept of “Single Market a Production Base” for ASEAN beyond 2015	Oct 2013
2013-24	Olivier CADOT Ernawati MUNADI Lili Yan ING	Streamlining NTMs in ASEAN: The Way Forward	Oct 2013
2013-23	Charles HARVIE, Dionisius NARJOKO, Sothea OUM	Small and Medium Enterprises’ Access to Finance: Evidence from Selected Asian Economies	Oct 2013
2013-22	Alan Khee-Jin TAN	Toward a Single Aviation Market in ASEAN: Regulatory Reform and Industry Challenges	Oct 2013

No.	Author(s)	Title	Year
2013-21	Hisanobu SHISHIDO, Shintaro SUGIYAMA, Fauziah ZEN	Moving MPAC Forward: Strengthening Public-Private Partnership, Improving Project Portfolio and in Search of Practical Financing Schemes	Oct 2013
2013-20	Barry DESKER, Mely CABALLERO-ANTHONY, Paul TENG	Thought/Issues Paper on ASEAN Food Security: Towards a more Comprehensive Framework	Oct 2013
2013-19	Toshihiro KUDO, Satoru KUMAGAI, So UMEZAKI	Making Myanmar the Star Growth Performer in ASEAN in the Next Decade: A Proposal of Five Growth Strategies	Sep 2013
2013-18	Ruperto MAJUCA	Managing Economic Shocks and Macroeconomic Coordination in an Integrated Region: ASEAN Beyond 2015	Sep 2013
2013-17	Cassy LEE and Yoshifumi FUKUNAGA	Competition Policy Challenges of Single Market and Production Base	Sep 2013
2013-16	Simon TAY	Growing an ASEAN Voice? : A Common Platform in Global and Regional Governance	Sep 2013
2013-15	Danilo C. ISRAEL and Roehlano M. BRIONES	Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines	Aug 2013
2013-14	Allen Yu-Hung LAI and Seck L. TAN	Impact of Disasters and Disaster Risk Management in Singapore: A Case Study of Singapore's Experience in Fighting the SARS Epidemic	Aug 2013
2013-13	Brent LAYTON	Impact of Natural Disasters on Production Networks and Urbanization in New Zealand	Aug 2013
2013-12	Mitsuyo ANDO	Impact of Recent Crises and Disasters on Regional Production/Distribution Networks and Trade in Japan	Aug 2013
2013-11	Le Dang TRUNG	Economic and Welfare Impacts of Disasters in East Asia and Policy Responses: The Case of Vietnam	Aug 2013
2013-10	Sann VATHANA, Sothea OUM, Ponhrith KAN, Colas CHERVIER	Impact of Disasters and Role of Social Protection in Natural Disaster Risk Management in Cambodia	Aug 2013
2013-09	Sommarat CHANTARAT,	Index-Based Risk Financing and Development of	Aug

No.	Author(s)	Title	Year
	Krirk PANNANGPETCH, Nattapong PUTTANAPONG, Preesan RAKWATIN, and Thanasin TANOMPONGPHANDH	Natural Disaster Insurance Programs in Developing Asian Countries	2013
2013-08	Ikumo ISONO and Satoru KUMAGAI	Long-run Economic Impacts of Thai Flooding: Geographical Simulation Analysis	July 2013
2013-07	Yoshifumi FUKUNAGA and Hikaru ISHIDO	Assessing the Progress of Services Liberalization in the ASEAN-China Free Trade Area (ACFTA)	May 2013
2013-06	Ken ITAKURA, Yoshifumi FUKUNAGA, and Ikumo ISONO	A CGE Study of Economic Impact of Accession of Hong Kong to ASEAN-China Free Trade Agreement	May 2013
2013-05	Misa OKABE and Shujiro URATA	The Impact of AFTA on Intra-AFTA Trade	May 2013
2013-04	Kohei SHIINO	How Far Will Hong Kong's Accession to ACFTA will Impact on Trade in Goods?	May 2013
2013-03	Cassey LEE and Yoshifumi FUKUNAGA	ASEAN Regional Cooperation on Competition Policy	Apr 2013
2013-02	Yoshifumi FUKUNAGA and Ikumo ISONO	Taking ASEAN+1 FTAs towards the RCEP: A Mapping Study	Jan 2013
2013-01	Ken ITAKURA	Impact of Liberalization and Improved Connectivity and Facilitation in ASEAN for the ASEAN Economic Community	Jan 2013
2012-17	Sun XUEGONG, Guo LIYAN, Zeng ZHENG	Market Entry Barriers for FDI and Private Investors: Lessons from China's Electricity Market	Aug 2012
2012-16	Yanrui WU	Electricity Market Integration: Global Trends and Implications for the EAS Region	Aug 2012
2012-15	Youngho CHANG, Yanfei LI	Power Generation and Cross-border Grid Planning for the Integrated ASEAN Electricity Market: A Dynamic Linear Programming Model	Aug 2012
2012-14	Yanrui WU, Xunpeng SHI	Economic Development, Energy Market Integration and Energy Demand: Implications for East Asia	Aug 2012
2012-13	Joshua AIZENMAN,	The Relationship between Structural Change and	July

No.	Author(s)	Title	Year
	Minsoo LEE, and Donghyun PARK	Inequality: A Conceptual Overview with Special Reference to Developing Asia	2012
2012-12	Hyun-Hoon LEE, Minsoo LEE, and Donghyun PARK	Growth Policy and Inequality in Developing Asia: Lessons from Korea	July 2012
2012-11	Cassey LEE	Knowledge Flows, Organization and Innovation: Firm-Level Evidence from Malaysia	June 2012
2012-10	Jacques MAIRESSE, Pierre MOHNEN, Yayun ZHAO, and Feng ZHEN	Globalization, Innovation and Productivity in Manufacturing Firms: A Study of Four Sectors of China	June 2012
2012-09	Ari KUNCORO	Globalization and Innovation in Indonesia: Evidence from Micro-Data on Medium and Large Manufacturing Establishments	June 2012
2012-08	Alfons PALANGKARAYA	The Link between Innovation and Export: Evidence from Australia's Small and Medium Enterprises	June 2012
2012-07	Chin Hee HAHN and Chang-Gyun PARK	Direction of Causality in Innovation-Exporting Linkage: Evidence on Korean Manufacturing	June 2012
2012-06	Keiko ITO	Source of Learning-by-Exporting Effects: Does Exporting Promote Innovation?	June 2012
2012-05	Rafaelita M. ALDABA	Trade Reforms, Competition, and Innovation in the Philippines	June 2012
2012-04	Toshiyuki MATSUURA and Kazunobu HAYAKAWA	The Role of Trade Costs in FDI Strategy of Heterogeneous Firms: Evidence from Japanese Firm-level Data	June 2012
2012-03	Kazunobu HAYAKAWA, Fukunari KIMURA, and Hyun-Hoon LEE	How Does Country Risk Matter for Foreign Direct Investment?	Feb 2012
2012-02	Ikumo ISONO, Satoru KUMAGAI, Fukunari KIMURA	Agglomeration and Dispersion in China and ASEAN: A Geographical Simulation Analysis	Jan 2012
2012-01	Mitsuyo ANDO and Fukunari KIMURA	How Did the Japanese Exports Respond to Two Crises in the International Production Network?: The Global Financial Crisis and the East Japan Earthquake	Jan 2012
2011-10	Tomohiro MACHIKITA and Yasushi UEKI	Interactive Learning-driven Innovation in Upstream-Downstream Relations: Evidence from	Dec 2011

No.	Author(s)	Title	Year
		Mutual Exchanges of Engineers in Developing Economies	
2011-09	Joseph D. ALBA, Wai-Mun CHIA, and Donghyun PARK	Foreign Output Shocks and Monetary Policy Regimes in Small Open Economies: A DSGE Evaluation of East Asia	Dec 2011
2011-08	Tomohiro MACHIKITA and Yasushi UEKI	Impacts of Incoming Knowledge on Product Innovation: Econometric Case Studies of Technology Transfer of Auto-related Industries in Developing Economies	Nov 2011
2011-07	Yanrui WU	Gas Market Integration: Global Trends and Implications for the EAS Region	Nov 2011
2011-06	Philip Andrews-SPEED	Energy Market Integration in East Asia: A Regional Public Goods Approach	Nov 2011
2011-05	Yu SHENG, Xunpeng SHI	Energy Market Integration and Economic Convergence: Implications for East Asia	Oct 2011
2011-04	Sang-Hyop LEE, Andrew MASON, and Donghyun PARK	Why Does Population Aging Matter So Much for Asia? Population Aging, Economic Security and Economic Growth in Asia	Aug 2011
2011-03	Xunpeng SHI, Shinichi GOTO	Harmonizing Biodiesel Fuel Standards in East Asia: Current Status, Challenges and the Way Forward	May 2011
2011-02	Hikari ISHIDO	Liberalization of Trade in Services under ASEAN+n : A Mapping Exercise	May 2011
2011-01	Kuo-I CHANG, Kazunobu HAYAKAWA Toshiyuki MATSUURA	Location Choice of Multinational Enterprises in China: Comparison between Japan and Taiwan	Mar 2011
2010-11	Charles HARVIE, Dionisius NARJOKO, Sothea OUM	Firm Characteristic Determinants of SME Participation in Production Networks	Oct 2010
2010-10	Mitsuyo ANDO	Machinery Trade in East Asia, and the Global Financial Crisis	Oct 2010
2010-09	Fukunari KIMURA Ayako OBASHI	International Production Networks in Machinery Industries: Structure and Its Evolution	Sep 2010
2010-08	Tomohiro MACHIKITA, Shoichi MIYAHARA, Masatsugu TSUJI, and	Detecting Effective Knowledge Sources in Product Innovation: Evidence from Local Firms and MNCs/JVs in Southeast Asia	Aug 2010

No.	Author(s)	Title	Year
	Yasushi UEKI		
2010-07	Tomohiro MACHIKITA, Masatsugu TSUJI, and Yasushi UEKI	How ICTs Raise Manufacturing Performance: Firm-level Evidence in Southeast Asia	Aug 2010
2010-06	Xunpeng SHI	Carbon Footprint Labeling Activities in the East Asia Summit Region: Spillover Effects to Less Developed Countries	July 2010
2010-05	Kazunobu HAYAKAWA, Fukunari KIMURA, and Tomohiro MACHIKITA	Firm-level Analysis of Globalization: A Survey of the Eight Literatures	Mar 2010
2010-04	Tomohiro MACHIKITA and Yasushi UEKI	The Impacts of Face-to-face and Frequent Interactions on Innovation: Upstream-Downstream Relations	Feb 2010
2010-03	Tomohiro MACHIKITA and Yasushi UEKI	Innovation in Linked and Non-linked Firms: Effects of Variety of Linkages in East Asia	Feb 2010
2010-02	Tomohiro MACHIKITA and Yasushi UEKI	Search-theoretic Approach to Securing New Suppliers: Impacts of Geographic Proximity for Importer and Non-importer	Feb 2010
2010-01	Tomohiro MACHIKITA and Yasushi UEKI	Spatial Architecture of the Production Networks in Southeast Asia: Empirical Evidence from Firm-level Data	Feb 2010
2009-23	Dionisius NARJOKO	Foreign Presence Spillovers and Firms' Export Response: Evidence from the Indonesian Manufacturing	Nov 2009
2009-22	Kazunobu HAYAKAWA, Daisuke HIRATSUKA, Kohei SHIINO, and Seiya SUKEGAWA	Who Uses Free Trade Agreements?	Nov 2009
2009-21	Ayako OBASHI	Resiliency of Production Networks in Asia: Evidence from the Asian Crisis	Oct 2009
2009-20	Mitsuyo ANDO and Fukunari KIMURA	Fragmentation in East Asia: Further Evidence	Oct 2009

No.	Author(s)	Title	Year
2009-19	Xunpeng SHI	The Prospects for Coal: Global Experience and Implications for Energy Policy	Sept 2009
2009-18	Sothea OUM	Income Distribution and Poverty in a CGE Framework: A Proposed Methodology	Jun 2009
2009-17	Erlinda M. MEDALLA and Jenny BALBOA	ASEAN Rules of Origin: Lessons and Recommendations for the Best Practice	Jun 2009
2009-16	Masami ISHIDA	Special Economic Zones and Economic Corridors	Jun 2009
2009-15	Toshihiro KUDO	Border Area Development in the GMS: Turning the Periphery into the Center of Growth	May 2009
2009-14	Claire HOLLWEG and Marn-Heong WONG	Measuring Regulatory Restrictions in Logistics Services	Apr 2009
2009-13	Loreli C. De DIOS	Business View on Trade Facilitation	Apr 2009
2009-12	Patricia SOURDIN and Richard POMFRET	Monitoring Trade Costs in Southeast Asia	Apr 2009
2009-11	Philippa DEE and Huong DINH	Barriers to Trade in Health and Financial Services in ASEAN	Apr 2009
2009-10	Sayuri SHIRAI	The Impact of the US Subprime Mortgage Crisis on the World and East Asia: Through Analyses of Cross-border Capital Movements	Apr 2009
2009-09	Mitsuyo ANDO and Akie IRIYAMA	International Production Networks and Export/Import Responsiveness to Exchange Rates: The Case of Japanese Manufacturing Firms	Mar 2009
2009-08	Archanun KOHPAIBOON	Vertical and Horizontal FDI Technology Spillovers:Evidence from Thai Manufacturing	Mar 2009
2009-07	Kazunobu HAYAKAWA, Fukunari KIMURA, and Toshiyuki MATSUURA	Gains from Fragmentation at the Firm Level: Evidence from Japanese Multinationals in East Asia	Mar 2009
2009-06	Dionisius A. NARJOKO	Plant Entry in a More LiberalisedIndustrialisationProcess: An Experience of Indonesian Manufacturing during the 1990s	Mar 2009
2009-05	Kazunobu HAYAKAWA, Fukunari KIMURA, and	Firm-level Analysis of Globalization: A Survey	Mar 2009

No.	Author(s)	Title	Year
	Tomohiro MACHIKITA		
2009-04	Chin Hee HAHN and Chang-Gyun PARK	Learning-by-exporting in Korean Manufacturing: A Plant-level Analysis	Mar 2009
2009-03	Ayako OBASHI	Stability of Production Networks in East Asia: Duration and Survival of Trade	Mar 2009
2009-02	Fukunari KIMURA	The Spatial Structure of Production/Distribution Networks and Its Implication for Technology Transfers and Spillovers	Mar 2009
2009-01	Fukunari KIMURA and Ayako OBASHI	International Production Networks: Comparison between China and ASEAN	Jan 2009
2008-03	Kazunobu HAYAKAWA and Fukunari KIMURA	The Effect of Exchange Rate Volatility on International Trade in East Asia	Dec 2008
2008-02	Satoru KUMAGAI, Toshitaka GOKAN, Ikumo ISONO, and Souknilanh KEOLA	Predicting Long-Term Effects of Infrastructure Development Projects in Continental South East Asia: IDE Geographical Simulation Model	Dec 2008
2008-01	Kazunobu HAYAKAWA, Fukunari KIMURA, and Tomohiro MACHIKITA	Firm-level Analysis of Globalization: A Survey	Dec 2008