EFFECTIVE AND FEASIBLE ASSESSMENT TOOLS OF RISKS, HAZARDS AND VULNERABILITIES ASSOCIATED WITH CLIMATE CHANGE IMPACTS: A CASE OF WATERSHED-BASED ADAPTATION TO CLIMATE CHANGE INITIATIVE IN THAILAND

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Globally, Thailand is among the countries most at risk to climate change impacts.

Given its long and populated coastline, the importance of the natural resource base to its economy and other factors,

Thailand is ranked no.11 in the Global Climate Risk Index 2015, produced by German watch.
Thailand’s vulnerability was strikingly demonstrated 4 years ago when devastating floods affected 65 of our 77 provinces causing an estimated US$45 billion worth of damage.

Despite this, however, most Thai people are still unclear about climate change impacts and what they can do to build climate resilience.
Climate Change Adaptation in Thailand
Creating awareness about climate change adaptation and resilience among Thailand’s decision makers and the population generally is one of the major challenges facing those of us who work in this field.

Among other key challenges are:

- National capacity to undertake vulnerability assessments and prepare appropriate recommendations based on the assessments;
- Development and application of appropriate technologies that strengthen climate resilience;

- National capacity to develop a pipeline of bankable climate change adaptation projects and programs that are worthy of both domestic and international financing;
- Instituting genuine stakeholder participation and consultation;

- Building national and local coalitions of government, civil society, academic and private sector representatives that can work together in tackling climate change impacts.
A number of steps have recently been taken by the Royal Thai Government to address these challenges. For example:

- A Climate Change Master Plan (2015-2050) covering mitigation and adaptation was recently prepared by the Ministry of Natural Resources and Environment and approved by the Cabinet.
Thailand’s recently submitted Intended Nationally Determined Contributions (INDCs) addresses climate change adaptation needs.

National Research Council of Thailand (NRCT) and its partners developed and are using a National Strategy for Climate Change Research.
The Ministry of Agriculture and Cooperatives produced a Strategic Plan on Climate Change for the Agriculture Sector 2012-2016.

A Master Plan on Sustainable Water Resource Management is under preparation.
Conceptual Pathway to NAP

Phase 1: 2015
- Vulnerability Assessment
- Vulnerability Database
- Proposed process of creating NAP

Phase 2: 2016
- Reviewing Best Practices
- Knowledge and Tech. from National/Local Projects and Programs
- Drafted NAP

Mitigation & Low-Carbon Cap. Building

Adaptation

Climate Change Master Plan (2015-2050)
Mitigation and Adaptation
NAP ph.2 Conceptual Framework

Projected Vulnerability Circumstance
Vulnerability Database
Suggestions of drafted NAP

Existing Knowledge
Local Technologies

Preparation
Research & Studies
Innovation
Beliefs

NAP

Co-benefit Projects
Int’l projects

National Archives
of Adaptation Methodologies

Protection and mitigation projects

Recovery Plans

June 22nd, 2015
Local-International Cooperation

- GIZ-BMUB:
  - CCMP Implementation
  - Risk-NAP Support

- UNDP: MADRiD Mainstreaming Disaster Risk Reduction and Climate Change Adaptation

- JICA: ADAP-T

- Ministerial Adaptation Plans: Health, Agriculture
Constraints and Opportunities

- Local research and studies
- Accessibility to and Contribution of Databases
- Indigenous Knowledge Database
- Knowledge and Awareness Gaps
- Socio-Economic Co-benefits Linkages

June 22nd, 2015
Vulnerability and Adaptation Analysis (VAA): The Phetchaburi Water Management Area Case Study

Introduction

1. Background/Rationale

2. Objectives

3. Research framework
   - Secondary data across full Phetchaburi Water Management Area plus focal watershed and three focal communities

4. Research spatial scope

5. Expected results
Vulnerability and Adaptation Analysis (VAA): The Phetchaburi Water Management Area Case Study

Introduction

1. Background/Rationale

- The Phetchaburi River is a river in western Thailand.
- It originates in Kaeng Krachan National Park, Kaeng Krachan district and flows through Tha Yang, Ban Lat, Mueang Phetchaburi and mouths into the Bay of Bangkok in Ban Laem district.
- It is 210 kilometres (130 mi) long, most of which is within the Phetchaburi Province and the backbone of this province.
Fig1. Location of Phetchaburi Watershed

Source: Irrigation Department 2010
Fig 2. Water Reservoir in Phetchaburi Watershed

Kaeng Krachan
Total Volume: 710 million m³
Average rainfall: 1,083 mm.

Mae Prachan
Total Volume: 42.2 million m³
Average rainfall: 1,475 mm.

Huai Pak Reservoir
Total Volume: 27.5 million m³
Average rainfall: 966 mm.

Total area: 6,260.17 km²
- Irrigation line 28 line
- 246 km³

Source: Irrigation department 2010
Amount of Water at Kaeng Krachan Reservoir 2003 - 2014

**Sources:** Irrigation Department
The Watershed-based Adaptation to Climate Change (WACC) initiative

Aims to develop a flexible and effective framework for climate vulnerability and capacity assessment (VCA) at the river basin level.
WACC serves as a model for future such vulnerability and capacity assessment (VCA) in Thailand.

The study site is a river basin in south-central Thailand which provides water and other ecological services to rapidly growing provinces dependent on agriculture and tourism for a significant proportion of their economy.
Description of the Study Area

1. Geography of area and study communities
2. Terrain and watersheds
3. Meteorology
4. Hydrogeology
5. Forests, soils, and biodiversity
6. Socioeconomic
7. Map of population and settlements
8. Administrative structure
9. Household economy
10. Economic activities
11. Social and cultural traditions
Methodologies

1. Climate projection
2. Land-use Assessment
3. Forest and biodiversity assessment
   - Phetchaburi Water Management Area (secondary data)
   - Focal Watershed
   - Case study of SIEP
Climate projection
Downscaling Procedures

Statistical downscaling technique applied in this study has 4 main steps:

1) Develop quantitative functions between predictors (base year data from GCMs) and predictands (statistical data from meteorological stations) by using ANN.

2) Apply the functions to project future point station data with future data from GCMs as predictors.

3) Generate grid data from future point station data

4) Calibration of grid data.
GCM : New Earth system model of Max Plank Institute for Meteorology, MPI-ESM-MR (medium resolution grid)

Coupled Models Intercomparison Project Phase 5 (CMIP5)

Representative Concentration Pathways (RCPs) : RCP4.5 and RCP8.5
Water Evaluation and Planning (WEAP) system: method

- GCM-MPI-ESM-MR
  - RCP4.5, and 8.5
- Dynamical Downscaling:
  - 25 km x 25 km
- Statistical Downscaling:
  - ANN: 5 km x 5 km
- Water Evaluation and Planning (WEAP) system

- Petchaburi and Prachuap Khiri Khan River Basins
- Explore alternative management options within the context of a changing climate
**WEAP model**

- The climate data sets from the downscaling process are input to WEAP model to evaluate the impact of climate change on water resources management in the study area.

- WEAP system will allow decision makers to explore alternative management options within the context of a changing environment, including climate.
WEAP model

• WEAP will be the key tool used in the project to integrate existing data with hydrology modeling and scenarios for future climate, water consumption by sector and upstream water use.

• WEAP is a highly graphical, computer based quantitative simulation tool for integrated water resources planning that provides a comprehensive, flexible and user-friendly framework for water policy analysis.

• WEAP facilitates water simulation, forecasting, and policy analysis by tracking, for example, water demand, supply, runoff, stream flow, storage, pollution generation, treatment and discharge, and in-stream water quality to help evaluate the full range of water development and management options, and takes account of multiple and competing uses of water systems.

• The WEAP model is ideally suited to explore water supply/demand in support of integrated water resource management planning
WEAP Application Development Flow Chart

**Study Definition**
- Spatial Boundary
- Time Horizon
- System Components
- Network Configuration

**Current Accounts**
- Demand
- Reservoir Characteristics
- River Simulation
- Pollutant Generation
- Resources and Supplies
- Wastewater Treatment

**Scenarios**
- Demographic and Economic Activity
- Patterns of Water Use, Pollution Generation
- Water System Infrastructure
- Hydropower
- Allocation, Pricing and Environmental Policy
- Component Costs
- Hydrology

**Evaluation**
- Water Sufficiency
- Pollutant Loadings
- Ecosystem Requirements
- Sensitivity Analysis
Methodologies

Social Vulnerability Analysis

- Phetchaburi Water Management Area
- Focal communities
- Quantitative data
  - Key informants and quantitative data collection methods.
  - Tools used in the collection of quantitative data.
  - Compilation of data from questionnaire
  - Quantitative Data Analysis
Methodologies

Social Vulnerability Analysis

- Qualitative data
  - The group provides information and qualitative data collection methods.
  - Tools used to collect and store data.
  - Compilation of qualitative information.
  - Analysis of qualitative data
Drivers in Phetchaburi

Climate Drivers

- Key Drivers
  - Changes in precipitation and water supply (drought)
  - Changes in storms/floods
  - Effects of warming on habitat/forests
  - Sea water intrusion
- Future climate expectations
Drivers in Phetchaburi

Climate Drivers

- Climate projections from downscaled climate modeling
  - Primary Indicators (mean temperature, nighttime low temperature, daytime highs)
  - Phetchaburi Water Management Area
Drivers in Phetchaburi

Climate Drivers

- Climate projections from downscaled climate modeling (Cont.)
  - Focal communities
    - Kaeng Krachan Cha- Ya Plong
    - Ban Lat Khao Yoi Phetchaburi, Tha Yang district and parts of the city
    - Ban Laem Some of Muang Lat and Yang District
  - Comparison to regional climate model
  - Results from WEAP modeling
Drivers in Phetchaburi

Climate Drivers

- Non-Climate Drivers
  - Phetchaburi Water Management Area
  - Focal communities
    - Kaeng Krachan Cha- Ya Plong
    - Ban Lat Khao Yoi Phetchaburi, Tha Yang district and parts of the city
    - Ban Laem Some of Muang Lat and Yang District
Analysis of vulnerability in Phetchaburi Basin in Phetchaburi

Social vulnerability.

- Possible examples: Description and map of land use;
- Allocations of water for different uses under different water levels.
- Present logic model to explain connection between climate driver and influence on values at risk.
Analysis of vulnerability in Phetchaburi Basinin Phetchaburi

Examples: Water supply for agriculture, Specialty crops.

- Phetchaburi Water Management Area
- Focal Communities
  - Kaeng Krachan Cha-Ya Plong
  - Ban Lat Khao Yoi Phetchaburi, Tha Yang district and parts of the city
  - Ban Laem Some of Muang Lat and Yang District
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  - Ban Laem Some of Muang Lat and Yang District
Analysis of vulnerability in Phetchaburi Basin in Phetchaburi

Ecological vulnerability: Possible examples: Forest vegetation, soils, and habitat conditions, Biodiversity conditions

- Phetchaburi Water Management Area
- Focal Watershed
- SIEP Watershed Case Study
Capacity

- Phetchaburi Water Management Area
- Focal Communities
  - Upper Basin Phetchaburi
  - Central Phetchaburi Basin Creek Watershed Mae Prachan
  - Lower Basin Phetchaburi
Adaptation Options (assessing options for adapting to climate change)

- Review each of the key topics identified through social (and ecological) analysis.

- Identify strategies to increase resilience to climate change.

- Present logic model to explain support for strategy (such as local or traditional knowledge, experience from comparable socio-ecosystems, experimental evidence)
  - Connection to national and provincial development plans
  - Implementation options
Adaptation Options (assessing options for adapting to climate change)

- Monitoring
  - Database / Web-based Library
  - Social indicators of sustainability
  - Ecological indicators of sustainability
  - Monitoring strategy for indicators
Conclusion and recommendation

- Climate trends in the future (30 years)
  - Key Vulnerabilities in the Phetchaburi Basin
  - Social Vulnerabilities
  - Ecological Vulnerabilities
  - Important knowledge gaps
  - Recommended Adaptation Strategies
Guidelines and Lessons Learned

- Steps in Conducting a VAA
- Essential elements of a VAA
- Principles of excellent VAA
- Biggest hurdles
- Biggest opportunities
- Advantages of harmonizing the approach across SE Asia
These include, for example:

Preparing “climate scorecards” to facilitate systematic assessment of the potential capacity of government agencies and local authorities in adapting to climate change;

**Organizational Capacity**
1. Employee education
2. Designated climate change coordinators
3. Program guidance

**Mitigation & Sustainable Consumption**
9. Carbon assessment and stewardship
10. Sustainable operations

**NRCT (National Research Council of Thailand)**

**Adaptation**
6. Assessing vulnerability
7. Adaptation actions
8. Monitoring

**Engagement**
4. Science and management partnerships
5. Other partnerships

NRCT (National Research Council of Thailand)
These include, for example:

Identifying “candidate communities” deemed likely to be representative of communities across the wider river basin in terms of climate impacts;
These include, for example:

Developing a set of “climate facets” based on WMO’s climate extremes indices that will help to characterize potential climate impacts in language that local communities can understand.
Major WACC outputs are expected to include:

- A model VCA for a river basin and accompanying guidelines that can be used to guide the preparation of VCAs at Thailand’s remaining 24 river basins;
Recommendations drawn from the VCA findings for appropriate and cost-effective adaptation measures which are integrated into local and sub-national development programs

A climate change adaptation learning center at the site; and

An international conference to be held next June.
Research on soil, land use and impact on climate change

**Database**
- Plantation
- Livestock
- Fisheries
- LDD Databases

**Survey**
- Data Collection
- Real time
  - Management
  - Yields
  - Cost
  - Revenue
  - Benefits
  - Problem
  - Impact from Climate Change

**Meteorology**
- Topography
- Soil and Land Use

**GIS**
- RS Database
- Information Technology

By: Land Development Department
Modeling land utilization and soil cover by using quantitative analysis, important factors, land utilization relative and dynamic model.

CLUE –S (The Conversion of Land Use and its Effects at Small Regional Extent)

Research Procedure

CLUE-S Model
Land use classification, impact from climate change on agricultural sector

Study climate change and land utilization information in recent 10 years.
Economics
Major people often do plantation, fisheries and livestock. All of this are produce large amount of income.

Important Jobs: Farmer Fisherman

Agriculture
Phetchaburi has 835,377 agricultural areas or 21.47% of total areas, 54,044 farmer households or 68.42% of all households. Most people in Phetchaburi often do agriculture as main occupation.

Important Crops: Rice, Pineapple, Sugarcane, Corn, Vegetables, Papaya, Lemon and Coconut
Basin Area in Phetchaburi Province

<table>
<thead>
<tr>
<th>Order</th>
<th>Basin Area (sq.km)</th>
<th>Basin Area (sq.km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upper Phetchaburi</td>
<td>3,147</td>
</tr>
<tr>
<td>2</td>
<td>Huaimaeprachan</td>
<td>1,100</td>
</tr>
<tr>
<td>3</td>
<td>Lower Phetchaburi</td>
<td>1,350</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>5,603</strong></td>
</tr>
</tbody>
</table>

**Project area**
Soil Moisture: Surface by Air Force Weather Agency (AFWA) database
From May 2014-April 2015
Soil Groups in Phetchaburi

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Area (Hectare)</th>
<th>Bangtran Oi</th>
<th>Huai Sai</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low land</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>104.40</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>101.40</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>158.10</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>131.40</td>
<td>135.10</td>
<td></td>
</tr>
<tr>
<td><strong>Upland</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>734.50</td>
<td>455.00</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>232.70</td>
<td>26.50</td>
<td></td>
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<tr>
<td>43</td>
<td>243.90</td>
<td>0.00</td>
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<tr>
<td>44</td>
<td>2,383.10</td>
<td>1,310.30</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>127.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>952.70</td>
<td>159.10</td>
<td></td>
</tr>
<tr>
<td><strong>Un-classify</strong></td>
<td>805.80</td>
<td>121.50</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,975.10</td>
<td>2,207.50</td>
<td></td>
</tr>
</tbody>
</table>
Soil Series in Phetchaburi

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Area (Hectare)</th>
<th>Bangthanoi</th>
<th>Huai Sai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chon Buri series: Cb</td>
<td>103.20</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Watthana series: Wa</td>
<td>122.50</td>
<td>36.40</td>
<td></td>
</tr>
<tr>
<td>Samutprakan series: Sm</td>
<td>56.10</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Nong Kae series: Nk</td>
<td>851.60</td>
<td>275.90</td>
<td></td>
</tr>
<tr>
<td>Hoop Kapong series: Hg</td>
<td>2,998.40</td>
<td>1,594.40</td>
<td></td>
</tr>
</tbody>
</table>

6 Soil Series in Phetchaburi
Land Used in Phetchaburi

<table>
<thead>
<tr>
<th>Land Utilization</th>
<th>Area (Hectare)</th>
<th>Bangtran</th>
<th>Huai Sai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban and built-up land (U200)</td>
<td>2.5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mixed orchard (A401)</td>
<td>334.0</td>
<td>327.1</td>
<td></td>
</tr>
<tr>
<td>Mixed orchard - Shrub or grassland (A401)</td>
<td>522.3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Shrub or grassland (A401)</td>
<td>973.0</td>
<td>980.9</td>
<td></td>
</tr>
<tr>
<td>Bush fallow (A200)</td>
<td>0.0</td>
<td>132.1</td>
<td></td>
</tr>
<tr>
<td>Acacia (A308)</td>
<td>63.3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grassland (M101)</td>
<td>0.0</td>
<td>622.6</td>
<td></td>
</tr>
<tr>
<td>Rice paddy (A102)</td>
<td>171.8</td>
<td>238.5</td>
<td></td>
</tr>
<tr>
<td>Rice paddy (irrigation area) (IA102)</td>
<td>453.0</td>
<td>158.7</td>
<td></td>
</tr>
<tr>
<td>Mixed forest (F201)</td>
<td>1,179.2</td>
<td>1,331.3</td>
<td></td>
</tr>
<tr>
<td>Disturbed deciduous forest (F200)</td>
<td>18.6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mixed field crops (A201)</td>
<td>54.7</td>
<td>389.1</td>
<td></td>
</tr>
<tr>
<td>Recreational area (U601)</td>
<td>32.8</td>
<td>270.2</td>
<td></td>
</tr>
<tr>
<td>Government’s department and other institutes (U3)</td>
<td>374.3</td>
<td>231.6</td>
<td></td>
</tr>
<tr>
<td>Mixed deciduous forest (F5)</td>
<td>547.6</td>
<td>3,529.8</td>
<td></td>
</tr>
<tr>
<td>Pine-apple (A205)</td>
<td>979.5</td>
<td>4,043.4</td>
<td></td>
</tr>
</tbody>
</table>
Hotspot in Phetchaburi

November 2014
Based-line Data

Soil fertility level

Fertility Level | Area (Hectare) |
----------------|----------------|
| Bangtranoi     | Huai Sai       |
| Low            | 5,975.8        | 2,207.4        |
| Total          | 5,975.8        | 2,207.4        |

Fertility Level:
- Low
- Moderate
- High
Based-line Data

Potassium

<table>
<thead>
<tr>
<th>Potassium Level (mg/kg)</th>
<th>Area (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Slightly (&lt;30)</td>
<td>Bangtranoi: 3,352.3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly</td>
<td>994.5</td>
</tr>
<tr>
<td>High</td>
<td>60 – 90</td>
</tr>
<tr>
<td>Very High</td>
<td>90 – 120</td>
</tr>
</tbody>
</table>

Based on the data, Bangtranoi has a higher area with very slightly potassium levels compared to Huai Sai. Bangtranoi also has more area with slightly and high potassium levels than Huai Sai.
Based-line Data

Soil organics matter (%)

- < 0.5: Very Slightly
- 0.5 – 1.5: Slightly
- 1.5 – 2.5: Moderately
- 2.5 – 3.5: High
- > 3.5: Very High

<table>
<thead>
<tr>
<th>Soil organics matter (%)</th>
<th>Area (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangtra noi</td>
<td>Huaisai</td>
</tr>
<tr>
<td>Very Slightly (&lt;0.5)</td>
<td>139.18</td>
</tr>
<tr>
<td>Slightly (0.5-1.5)</td>
<td>4207.71</td>
</tr>
<tr>
<td>Total</td>
<td>4346.90</td>
</tr>
</tbody>
</table>
Based-line Data

Carbon level (%)

- < 0.58 Very Slightly
- 0.58 – 0.87 Slightly
- 0.87 – 1.45 Moderately
- 1.45 – 2.03 High
- > 2.03 Very High

<table>
<thead>
<tr>
<th>Carbon in soil (%)</th>
<th>Area (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangtra noi</td>
<td></td>
</tr>
<tr>
<td>Very Slightly (&lt;0.58)</td>
<td>3,548.5 1</td>
</tr>
<tr>
<td>Slightly (0.58-0.87)</td>
<td>798.38 686.02</td>
</tr>
</tbody>
</table>
Based-line Data

Hydraulic Conductivity (cm/hr.)

<table>
<thead>
<tr>
<th>Hydraulic Conductivity (cm/hr.)</th>
<th>Area (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Bangtra noi</th>
<th>Huaisai</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5.0</td>
<td>3,012.7</td>
<td>1,275.2</td>
</tr>
<tr>
<td>2.5 – 5.0</td>
<td>2,882.1</td>
<td>932.3</td>
</tr>
<tr>
<td>1.5 – 2.5</td>
<td>81.0</td>
<td>-</td>
</tr>
<tr>
<td>0.5 – 1.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>&lt; 0.5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Based-line Data

Annual rainfall
(Millimeter/Year)

Low
800 – 900 mm./year

High
4,361

Low
534
Drought hazard

Based-line Data

L1: Slight (Plain)
L2: Moderate (Plain)
L3: High (Plain)
H1: Slight (Upland)
H2: Moderate (Upland)
H3: High (Upland)
Based-line Data

Flood hazard

- Very Slightly
- Slightly
- Moderately
- Severely
- Very Severely
- High area
Based-line Data

Landslide

Landslide
- Very slightly
- Slightly
- Moderately
- Severely
- Very severely
- Total

Landslide Impact
- Very slightly
- Slightly
- Moderately
- Severely
- Very severely
Hydraulic level (liter/hectare/year)

- 0 - 444,144
- 444,144 - 1,332,437
- 1,332,437 - 2,220,725
- 2,220,725 - 3,020,188
- 3,020,188 - 3,819,650
- 3,819,650 - 5,240,919
- 5,240,919 - 7,283,988
- 7,283,988 - 9,327,056
- 9,327,056 - 14,301,475
- 14,301,475 - 22,740,250
Water Balance

0 – Water is not enough for plantation
1 – Water may be not enough for plantation
2 – Water is enough for plantation

Based-line Data
Based-line Data

<table>
<thead>
<tr>
<th>Soil problem</th>
<th>Area (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4: Sandy saline soil with bad water absorption</td>
<td>131.4</td>
</tr>
<tr>
<td>4.3: Nearly sandy soil with bad water absorption and duripan</td>
<td>978.6</td>
</tr>
<tr>
<td>5.2: Sandy soil</td>
<td>2839.7</td>
</tr>
<tr>
<td>7: Soil complex</td>
<td>856.3</td>
</tr>
<tr>
<td>8.1: Clay with bad water absorption</td>
<td>104.4</td>
</tr>
<tr>
<td>8.3: Clay and loam with good water absorption</td>
<td>259.2</td>
</tr>
<tr>
<td>9: Government place and urban area</td>
<td>340.8</td>
</tr>
<tr>
<td>10: Other area</td>
<td>348.6</td>
</tr>
<tr>
<td>12: Water resource</td>
<td>116.4</td>
</tr>
</tbody>
</table>
Based-line Data
Activities

Drone
## Classify Target Area

<table>
<thead>
<tr>
<th>Project Area</th>
<th>Area (Hectare)</th>
<th>Huai Sai (HY)</th>
<th>Area (Hectare)</th>
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<tbody>
<tr>
<td><strong>Upstream</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN1</td>
<td>1916.1</td>
<td>HY1</td>
<td>1231.5</td>
</tr>
<tr>
<td><strong>Midstream</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN2</td>
<td>2062.5</td>
<td>HY2</td>
<td>664.3</td>
</tr>
<tr>
<td>BN3</td>
<td>1997.2</td>
<td>HY3</td>
<td>311.6</td>
</tr>
<tr>
<td><strong>Downstream</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5975.8</td>
<td></td>
<td>2207.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
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</table>
## Research Progress

### Upstream, Midstream and Downstream in Bangtranoi and Huai Sai

<table>
<thead>
<tr>
<th>Order</th>
<th>Parameter</th>
<th>Sampling Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH 1:1*</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>EC saturate*</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Organic matter, OM*</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Available P*</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Exchange K*</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Lime Requirement</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cation exchange capacity</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>Base saturation (%BS)</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>Available Water Capacity</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>Total water ciric soluble</td>
<td>12</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Order</th>
<th>Parameter</th>
<th>Sampling Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Available N</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>Exchange Ca</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>Exchange Mg</td>
<td>12</td>
</tr>
<tr>
<td>14</td>
<td>Extractable Na</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>Extractable Cu</td>
<td>12</td>
</tr>
<tr>
<td>16</td>
<td>Extractable Fe</td>
<td>12</td>
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<tr>
<td>17</td>
<td>Extractable Mn</td>
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</tr>
<tr>
<td>18</td>
<td>Extractable Zn</td>
<td>12</td>
</tr>
<tr>
<td>19</td>
<td>Extractable Cl</td>
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</tbody>
</table>
Soil and water erosion

Soil Sampling

67 Soil Samplings
Determine Soil Samplings

Upstream
Midstream
Downstream

Huai Sai Bangtran

Soil and water erosion

<table>
<thead>
<tr>
<th>Order</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH 1:1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>EC saturate</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Organic matter, OM</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>Available P</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Exchange K</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cation exchange capacity (C.E.C)</td>
<td>67</td>
</tr>
<tr>
<td>7</td>
<td>Available N</td>
<td>67</td>
</tr>
<tr>
<td>8</td>
<td>Exch. Ca</td>
<td>67</td>
</tr>
<tr>
<td>9</td>
<td>Exch. Mg</td>
<td>67</td>
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</tbody>
</table>
Soil and water erosion

Determine Piezometers

18 Piezometers
### Soil and water erosion

#### Analyze 18 soil samplings

<table>
<thead>
<tr>
<th>Order</th>
<th>Parameter</th>
<th>Amount (Points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH 1:1</td>
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</tr>
<tr>
<td>2</td>
<td>EC saturate</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Organic matter, OM</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Available P</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>Exchange K</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cation exchange capacity (C.E.C)</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Available N</td>
<td>18</td>
</tr>
<tr>
<td>8</td>
<td>Exch. Ca</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>Exch. Mg</td>
<td>18</td>
</tr>
</tbody>
</table>
Analyze water quality in Bangtranoi and Huai Sai sub-basin

<table>
<thead>
<tr>
<th>Order</th>
<th>Parameter</th>
<th>Amount (Points)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>pH</td>
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</tr>
<tr>
<td>2</td>
<td>EC</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Total Nitrate</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>Ca</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>Mg</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Na</td>
<td>18</td>
</tr>
</tbody>
</table>
Standard erosion plots

9 – 10 % slope

20-25 % slope

30 – 35 % slope

Real standard erosion plot site
Soil and water erosion

Analyze 6 soil standard erosion plots.

<table>
<thead>
<tr>
<th>Order</th>
<th>Parameter</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>Exchange K</td>
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<td>Exch. Ca</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Exch. Mg</td>
<td>6</td>
</tr>
</tbody>
</table>
Erosion Pins

This method consists of driving a pin into the soil so that the top of the pin gives a datum from which changes in the soil surface level can be measured. The pin should be a length which can be pushed or driven into the soil to give a firm, stable datum.
Landuse

Drone Technology

Land Use Change
Underground water and Surface water

18 Piezometer
Underground water and Surface water

18 Surface water
FOREST AND BIODIVERSITY
WACC is developing and testing approaches that can be applied at a landscape level to deliver useful conclusions.
SOCIOECONOMIC
Another challenge being addressed is undertaking effective stakeholder consultation and participation. This is a widespread weakness in Thailand.

WACC is emphasizing participation of local stakeholders, consensus building processes and in-depth analysis of socio-economic factors.
Scorecard Technique

- Scorecard is a way to improve organizational capacity and readiness to respond to climate change.

- Scorecard will better prepare for the journey in accomplishing the organization’s mission in the face of a changing climate and comply with the strategic plan.
Scorecard

1. Employee education –
Are resource specialists made aware of the potential contribution of their own work to climate change response?

   a. What climate change training is required of all employees on your Unit?

   b. What training have resource specialists had to increase awareness of the potential contribution of their own work to climate change response?
Scorecard

2. Climate Change coordinators - Is at least one employee assigned to coordinate climate change activities and be a resource for climate change questions and issues? Is this employee provided with the training, time, and resources to make his or her assignment successful?

   a. What is the name and contact information for the climate change coordinator on your Unit?

   b. What training, time, and resources is he or she provided to fulfill his or her responsibilities?
3. Program guidance – Does the Unit have written guidance for progressively integrating climate change considerations and activities into Unit-level operations?

   a. In what ways have you integrated climate change considerations and activities into your overall annual operations?
4. Science and Management Partnerships - Does the Unit actively engage with scientists and scientific organizations to improve its ability to respond to climate change?

a. How have your Unit and the science community collaborated and shared information to improve your ability to respond to climate change?

b. Who are your main science partners?
Scorecard

5. Other partnerships - Have climate change considerations and activities been incorporated into existing or new partnerships (other than science partnerships)?

   a. In what ways have climate change activities been incorporated into your existing or new partnerships?
Scorecard

6. Assessing vulnerability – Has the Unit engaged in developing relevant information about the vulnerability of key resources, such as human communities and ecosystem elements, to the impacts of climate change?

   a. What key resources have you identified on your Unit?

   b. What scientific, social, and economic information about the exposure and sensitivity of those resources to climate change have you reviewed and considered?

   c. What current stressors are you observing on your Unit? How do (or will) these stressors interact with a changing climate?
Scorecard

d. What historical climate data and climate projections have you examined? How might your key resources and their stressors be impacted by these climate changes?

e. Who have you consulted to help interpret the information you’ve collected?

f. How have you used this vulnerability information to prioritize possible management actions?
7. Adaptation actions – Does the Unit conduct management actions that reduce the vulnerability of resources and places to climate change?

a. What adaptation activities are you doing on your Unit to reduce the vulnerability of your key resources to climate change?

b. Are these activities aimed at increasing resilience to stressor impacts, promoting resistance to climate change, or facilitating transitions to respond adaptively to environmental change?
Scorecard

8. Monitoring - Is monitoring being conducted to track climate change impacts and the effectiveness of adaptation activities?

a. What current monitoring activities can be or are being used to track climate change impacts and the effectiveness of adaptation activities on your Unit?

b. What climate change related trends are you observing on your Unit?

c. How are you using this information to adjust your management activities?

d. What additional monitoring might need to be conducted?
Scorecard

9. Carbon assessment and stewardship - Does the Unit have a baseline assessment of carbon stocks and an assessment of the influence of disturbance and management activities on these stocks? Is the Unit integrating carbon stewardship with the management of other benefits being provided by the Unit?

a. Does your Unit have a baseline assessment of carbon stocks?

b. Does your Unit have an assessment of how disturbance and management activities are influencing carbon stocks or carbon sequestration and emissions? What is the basis for this assessment?

c. How is your Unit integrating carbon stewardship with the management of other benefits being provided by the Unit?
Scorecard

10. Sustainable operations - Is progress being made toward achieving sustainable operations requirements to reduce the environmental footprint of the Agency?

a. What actions has your Unit taken to make progress towards the sustainable operations targets listed in the definitions for this element?

b. What reductions in resource use were achieved as a result of these actions?

c. What support does your Unit provide for Green Teams, sustainable operations training, recognition programs, and other activities that foster a culture of sustainable consumption?
In terms of communication, the WACC initiative will serve as a useful example of how we might communicate climate change adaptation in a number of ways to a number of different audiences:

- The emphasis on stakeholder participation and consultation has already heightened the interest and awareness of both local residents and local and provincial decision makers.
Interest and awareness to increase further as we work with stakeholders to develop options to address the climate vulnerabilities of highest priority in the river basin.

The learning center’s interactive displays will bring messages on climate change adaptation to a wide variety of audiences, including school children, villagers, local government officers and tourists, to name a few.
The model VCA and the VCA guidelines will communicate to national government agencies the requirements in terms of finances, skills and time to undertake such work at other river basins. It will also convey messages concerning considerations when building inter-agency coalitions to prepare VCAs.

The international conference in June will expose a broad cross-section of Thai professionals to climate change adaptation considerations at the river basin level.
Looking to the future, we hope to build on initial participation in WACC by representatives from Cambodia, Lao PDR and Vietnam to explore regional cooperation to take forward the lessons learned from WACC at a sub-regional level.
Proposed Ideas for SIEP Exhibit on Resiliency to Climate Change

- Proposed exhibits will help visitors understand watershed ecology and climate change in general.

- Proposed exhibits will also provide detailed information about local conditions to put larger concepts in context.

- Detailed local information will pertain to the watershed areas above the park and the Petchaburi River watershed: how they have changed, how they are vulnerable to climate change, and adaptation actions (historical, ongoing and planned) to increase their resilience to climate change.
Proposed Ideas for SIEP Exhibit on Resiliency to Climate Change

- The Vulnerability Project will provide needed content for the exhibit.

- Several technologies both digital and hands-on would enhance communication of these ideas.

- Development of new maps, photos, and videos would provide visitors with an enhanced learning experience at the park.
## Proposed Ideas for SIEP Exhibit on Resiliency to Climate Change

<table>
<thead>
<tr>
<th>Topic</th>
<th>Technology Elements</th>
<th>Information from Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) What is a watershed? What is the watershed of SIEP? What is the watershed of the Phetchaburi River?</td>
<td>Interactive watershed sandbox</td>
<td>Digital elevation model of SIEP watershed, Petchaburi, and Pranburi watersheds</td>
</tr>
<tr>
<td></td>
<td>Raised relief map for SIEP and Petchaburi watersheds</td>
<td></td>
</tr>
<tr>
<td>1) How do communities use rivers and watersheds? How are the local historical changes in land use, changes in forest cover, and protected area?</td>
<td>Science on a Sphere Digital interactive maps</td>
<td>Satellite imagery and maps from land development, map of areas protected by the King, data from biodiversity studies and forest plots</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) What is climate change? What are projected impacts of climate change?</td>
<td>Science on a Sphere Digital interactive maps</td>
<td>Analyses from R. University</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Vulnerability Assessment: What are the greatest vulnerabilities?</td>
<td>Digital interactive maps</td>
<td>Project case studies with photos and videos</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Adaptation Planning: What are the planned adaptation strategies and tools?</td>
<td>Digital wall displays linked to map</td>
<td>Project case studies with photos and videos and relationships to the King’s initiatives</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**Examples for:**
- Forest restoration
- Agriculture
- Water conservation
- Community education
The Augmented Reality Sandbox. Left: Sandbox unit when turned off. The Kinect 3D camera and the digital projector are suspended above the sandbox proper from the pole attached to the back. Right: Sandbox table when on.
This domestic coalition is being helped in technical matters by USAID and the US Forest Service.

Lessons learned here on how to effectively establish and manage such a coalition of Thai professionals, and the possible roles of international partners, will be an important WACC output.
NRCT has built a coalition of Thai institutions from government, civil society and academia.

The private sector, including Toyota Motors Thailand, Ltd., has also expressed interest in supporting the initiative.
The success of the WACC initiative – and indeed, future initiatives of this kind -- will depend to a large extent on our ability to establish and maintain effective coalitions and partnerships.
CONCLUSIONS
Adaptation Challenges

- Weaknesses in overall governance within counties as well as weaknesses related to the process for addressing adaptation
Adaptation Challenges

- Poor structuring coordination among different stakeholders
- Financing of government
- Inadequate provision for civil society engagement, and laws.
Adaptation Challenges

- Policies and regulations that are ineffective in addressing non-climate stresses and concerns
- Capacity to cooperate and coordinate the development of trans boundary management plans and adaptation strategies.
Barriers related to Adaptation Process

- Poor understanding of adaptation concepts
- Low capacity to translate and apply climate information
- Limited knowledge of adaptation options and how to assess them
Barriers related to Adaptation Process

- Lack of capacities to design, implement, and monitor
- Lack of sector and stakeholder cooperation in adapting planning
THANK YOU