Community Based Measuring and Prioritizing Adaptation Actions in Agriculture Sector of the Gangetic Basin

SVRK Prabhakar
With study partners in Bangladesh, India and Nepal

Institute for Global Environmental Strategies
Japan

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Outline

- Project on adaptation metrics
- Background to adaptation metrics
  - Determinants, criteria and types of adaptation metrics
  - Adaptation metrics in Agriculture
    - Methods to identify metrics
    - Suggested metrics
- Our approach
  - Quantitative approach for measuring adaptation effectiveness through developing LaIn
  - Qualitative approach for prioritizing adaptation actions using AHP
- Way Forward
Project Background

- Project on ‘Adaptation Metrics’, with funding from Suishinhi (S8-3-4)

- Objectives
  - To identify suitable adaptation metrics for agriculture sector in the Gangetic Basin
  - To identify suitable adaptation decision making frameworks for operationalizing adaptation metrics

- Methodology
  - Literature review
  - Expert consultation and policy dialogues
  - Questionnaires (web, Climate L) and field visits
  - Multi-criteria analysis for bottom-up indicators
Study Location

Kanpur Dehat, India  Bara and Parsa, Nepal  Chapai Nawabganj, Bangladesh

Boundary of Gangetic Basin (Approx)

Motivation Behind this Work
Need for Metrics: BAP on Adaptation (Section c, i-v) and subsequent texts

- “Enhanced action on adaptation with consideration of ... prioritization of actions ... and support adaptation in a coherent and integrated manner”

- “Positive incentives for developing countries for enhanced mitigation and adaptation actions”
How to Prioritize and Incentivize Adaptation Actions?

- By
  - Knowing how much ‘adaptation’ we want to achieve in a project/program
  - Knowing where we want to go (adaptation targets?)
  - Setting a time frame

- This is facilitated by
  - Setting a base line of adaptation (to compare the progress and effectiveness)
  - And agreeing on a measurement system (adaptation metrics)
## Adaptation Metrics: Mitigation vs Adaptation

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has a <strong>protocol</strong> (KP) that governs</td>
<td><strong>No ‘protocol’</strong> to govern adaptation</td>
</tr>
<tr>
<td>There are <strong>GHG reduction targets</strong> to meet with coordinated efforts</td>
<td><strong>There are no ‘adaptation targets’</strong> to meet</td>
</tr>
<tr>
<td><strong>Ways and means to measure</strong> the impact of collective actions</td>
<td><strong>No streamlined measurement system</strong> for adaptation</td>
</tr>
<tr>
<td>Global actions and global benefits (more organized at global level)</td>
<td>Mostly local actions and local benefits (with some undeniable global spillover benefits)</td>
</tr>
<tr>
<td><strong>Physical principles</strong> that govern mitigation</td>
<td>At nascent stages: Complex interaction of biophysical and socioeconomic elements</td>
</tr>
</tbody>
</table>
And...in addition

- Adaptation deals with systems
  - that are at different levels of adaptive capacity
  - Several adaptation options deferring in their effectiveness and outcomes
Adaptation Metrics

- Metric:
  - A system of measurement
  - The unit of measurement
  - Value of the unit
Advantages of Adaptation Metrics

- Ability to **measure adaptation** at any given point of time
- Provide a **means to compare** the level of adaptation reached across locations, regions, societies and nations
- Help in decision making related to **identification and prioritization** of appropriate adaptation actions and for funding
- Help **track the progress** over the time scales
- Help in **minimizing the risk of mal-adaptation**
Criteria for Adaptation Metrics

- Measurable
  - Cost effective
- Scalable
- Comparable
  - Across time and geographical scales
- Context specific
  - Specific to system being measured
- Sensitive to degree of adaptation
- Learning and evolving
Different metrics

- Qualitative and quantitative
  - Cost and time resources, effectiveness
- Direct and proxy
  - To accommodate those cannot be directly measured
- Ex-ante vs. Ex-post
  - To chose options and to measure outcomes
- Local vs National
  - To accommodate differential impacts of climate change at different scales
# Methods for Choosing Adaptation Metrics in Agriculture

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Geographical Scope</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit-cost analysis</td>
<td>Local (L), national (N) and regional (R) scales</td>
<td>Tubiello and Rosenzweig, 2008</td>
</tr>
<tr>
<td>Cost-effectiveness analysis</td>
<td>L,N,R</td>
<td>Rosenzweig and Tubiello, 2006</td>
</tr>
<tr>
<td>Multi-criteria analysis</td>
<td>L,N,R</td>
<td>Dolan et al., 2001</td>
</tr>
<tr>
<td>Expert consultation (workshops)</td>
<td>L,N,R</td>
<td>Rosenzweig and Tubiello, 2007</td>
</tr>
<tr>
<td>Dynamic crop models</td>
<td>L,N,R</td>
<td>Tubiello and Rosenzweig, 2008</td>
</tr>
<tr>
<td>Modelling relationship between stressor and outcome variables</td>
<td>L</td>
<td>Luers et al., 2003</td>
</tr>
<tr>
<td>GIS based index based on normalization and aggregation of determinants</td>
<td>Sub-national</td>
<td>Swanson et al., 2007</td>
</tr>
<tr>
<td>Historical trend analysis and constructing conceptual models</td>
<td>Sub-national</td>
<td>Allison and Hobbs, 2004</td>
</tr>
</tbody>
</table>

Prabhakar, 2012
### Some Suggested Adaptation Metrics

<table>
<thead>
<tr>
<th>Metric/s</th>
<th>Reference</th>
<th>Description on availability and limitations (includes authors judgement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean and variability of yield and production, income, aggregate of value added</td>
<td>Tubiello and Rosenzweig, 2008</td>
<td>Measured and computed metrics. Available at local, national, regional and international levels in many countries. The aggregate of value added may need to be computed at the local level as such statistics will not be readily available.</td>
</tr>
<tr>
<td>Nutrition index</td>
<td>Tubiello and Rosenzweig, 2008</td>
<td>Computed metric (sum of local production and net imports divided by total food demand). Can be computed at national and regional level.</td>
</tr>
<tr>
<td>Yield estimates (remotely sensed), yield variability, highest relative yield/yield percentile</td>
<td>Luers et al., 2003</td>
<td>Estimates could help in filling the gaps in the existing yield data, validating the measured yield data etc. Accuracy could be an issue when resolution of remote sensing is low.</td>
</tr>
<tr>
<td>Agricultural export, farm income, out-migration from farming, emergency payments</td>
<td>Venema, 2006</td>
<td>Agricultural exports and out-migration of farming are mostly applicable at the macro-economic level, while data on rest of the metrics (emergency payments) could be sparingly available.</td>
</tr>
<tr>
<td>Sources of income, livestock number, source of fertilizer</td>
<td>Brooks and Adger, 2005</td>
<td>It was not clear on how many sources of income is considered as optimal, and also the number of cattle. However, it is suggested that the higher the sources of income, with more diversification into non-farm sources, the higher the adaptive capacity.</td>
</tr>
</tbody>
</table>
Problems with Earlier Suggestions

- Mostly single metrics and doesn’t often provide an overall picture of adaptation in agriculture sector
- Policy makers may often prefer single composite index representing the entire sector with a single number (not withstanding their intrinsic limitation)
Our Approach
Research Methodology

- **Quantitative approach** for quantifying adaptation through local adaptation index (LaIn)

- **Qualitative approach** for prioritizing adaptation options: Multi-criteria analysis (MCA) using analytical hierarchy process (AHP)
Quantitative Approach

Local Adaptation Index (LaIn): Localizing GaIn

- **GaIn**: Comprehensive macro assessment of Vulnerability and Readiness of a country in a given year

- **LaIn**: Ultimate objective: Precise assessment of Vulnerability and Readiness at a given point of time (ex-ante and ex-post) at village level
LaIn vs GaIn

Same analytical framework

\[
\left[ \left( \sum_{i}^{\text{Read.}} \frac{\text{Index}_i - \text{Mean}_{\text{all}}(\text{Index}_i)}{\text{Stdev}_{\text{all}}(\text{Index}_i)} \right) \ast \text{Weight}_{\text{Index}} \right] / \text{Max}(\text{Score})_{\text{all}} \right] \ast 60 - \\
\left[ \left( \sum_{i}^{\text{Vu ln.}} \frac{\text{Index}_i - \text{Mean}_{\text{all}}(\text{Index}_i)}{\text{Stdev}_{\text{all}}(\text{Index}_i)} \right) \ast \text{Weight}_{\text{Index}} \right] / \text{Max}(\text{Score})_{\text{all}} \right] \ast 40
\]
Framework for Assessing the Effectiveness of Adaptation Action

\[ \text{Ae}_x = \text{Ac}_1 - \text{Ac}_0 \]

Where:
- \( \text{Ae}_x \): Effectiveness of adaptation action \( x \);
- \( \text{Ac}_0, \text{Ac}_1 \): Adaptive Capacity at times \( T_1 \) and \( T_2 \);
- \( \text{Ix}, \text{Iy}, \text{Iz} \): Interventions \( x, y, z \)
Review Literature for identifying indicators, Regional Consultation

Indicator vetting through Participatory Appraisal Processes

- Focused group discussions and ranking of indicators and criteria with researchers, local administration, and NGOs etc in each project country in GMS region
- Developing draft questionnaires for inputs from communities, local administration, NGOs and researchers
- Conduct pilot questionnaire surveys to test the usability of questionnaires
- Conduct actual surveys for identifying local effectiveness indicators
  - Participatory ranking of indicators and criteria
  - Quantification of indicators
- Incorporation of local effectiveness indicators into GaIn computation for arriving at LaIn
- Conduct consultations with local admin and NGOs etc to identify strengths and weaknesses for mainstreaming LaIn into their decision making process

Integrating LaIn into local decision making mechanisms
Multi-criteria Ranking of Indicators

- Carried out with experts in each country during the indicator vetting meetings

<table>
<thead>
<tr>
<th>Policy relevance (policy design or implementation)</th>
<th>Spatial scalability (applicability at local, regional, national and/or global scales)</th>
<th>Cost-effectiveness</th>
<th>Measurability (readily measurable/quantifiable)</th>
<th>Simplicity (readily understandable)</th>
<th>Comparability (across projects, sectors and geographical areas)</th>
<th>Responsive to changes in the extent of effectiveness of adaptation</th>
<th>Communicability (in a simple concise manner or systemic metrics)</th>
<th>Temporal relevance (for short, medium and long durations)</th>
<th>Scientific basis and ability to disaggregate in terms of geographical differences (measurable at local level)</th>
<th>Transparency</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental effectiveness</td>
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<td></td>
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<tr>
<td>Period of fresh water availability</td>
<td>7</td>
<td>4.5</td>
<td>7</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Number of floods or droughts</td>
<td>6.5</td>
<td>7</td>
<td>3.5</td>
<td>1.5</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
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</tr>
<tr>
<td>Soil cover (duration and extent)</td>
<td>8.5</td>
<td>8.5</td>
<td>8</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
<td>6.5</td>
<td>6</td>
<td>5.5</td>
<td>10</td>
<td>6</td>
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<tr>
<td>Net primary production (total biomass produced by)</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>3.5</td>
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<td>Change in groundwater level</td>
<td>3</td>
<td>3.5</td>
<td>3.5</td>
<td>3</td>
<td>3.5</td>
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<td>3.5</td>
<td>3</td>
<td>3.5</td>
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<tr>
<td>% of farms that have concerns related to soil erosion</td>
<td>4.5</td>
<td>4.5</td>
<td>3</td>
<td>6</td>
<td>2.5</td>
<td>4</td>
<td>5.5</td>
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<td>2.5</td>
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<tr>
<td>Crop protection in soil and vegetation</td>
<td>1</td>
<td>3.5</td>
<td>2.5</td>
<td>2.5</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Change in biodiversity</td>
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<td>9.5</td>
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<td>6.5</td>
<td>5.5</td>
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<td>7</td>
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<td>4</td>
<td>7</td>
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<tr>
<td>Nutrient balance in soil and water systems</td>
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<td>2.5</td>
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<td>2.5</td>
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<td>1.5</td>
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<tr>
<td>Change in cropping intensity</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>5</td>
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<tr>
<td>Soil physico-chemical and biological conditions (soil moisture holding capacity, earthworms etc)</td>
<td>10</td>
<td>10</td>
<td>6.5</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Social effectiveness</td>
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<td></td>
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</tr>
<tr>
<td>Calorie intake per person (indicator of access to and availability of food)</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>2.5</td>
<td>4.5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3.5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>% of households having access to primary health care</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>4.5</td>
<td>1</td>
<td>3</td>
<td>4.5</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>% of households having access to sanitation facilities</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>% of households having access to information</td>
<td>3.5</td>
<td>3.5</td>
<td>6</td>
<td>1</td>
<td>2.5</td>
<td>2.5</td>
<td>1.5</td>
<td>3.5</td>
<td>2</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>% of children under the age of five with symptoms of illness</td>
<td>3</td>
<td>3.5</td>
<td>1.5</td>
<td>2</td>
<td>1</td>
<td>4.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% of households having access to safe drinking water</td>
<td>4</td>
<td>4</td>
<td>2.5</td>
<td>1</td>
<td>2</td>
<td>3.5</td>
<td>3</td>
<td>6</td>
<td>2</td>
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<tr>
<td>Employment rate</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>3.5</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Social capital (e.g. number of social networks)</td>
<td>2.2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>5.5</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>% of households participating in local disaster</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>% of households having access to markets</td>
<td>3.5</td>
<td>3.5</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>6.5</td>
<td>6.5</td>
<td>1</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Asset ownership (men and women)</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>GINI coefficient for equity</td>
<td>2.5</td>
<td>4.5</td>
<td>3.5</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>1</td>
<td>3.5</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Gender equity (% of women farmers participating in agriculture/decision making, committees etc., women)</td>
<td>5</td>
<td>4.5</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>3</td>
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<tr>
<td>Economic effectiveness</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Crop yield and yield variability</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>2.5</td>
<td>3</td>
<td>3</td>
<td>5.5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Market price of commodities (including variation)</td>
<td>1.5</td>
<td>2.5</td>
<td>1</td>
<td>6.5</td>
<td>7</td>
<td>1</td>
<td>5.5</td>
<td>8</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Market price of agro inputs</td>
<td>1</td>
<td>2.5</td>
<td>1</td>
<td>6.5</td>
<td>7</td>
<td>1</td>
<td>5.5</td>
<td>8</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Cost-benefit ratio and internal rate of return of investment</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Household income and its inter-annual stability</td>
<td>4.5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>% of households having access to credit</td>
<td>8</td>
<td>4.5</td>
<td>4</td>
<td>6.5</td>
<td>3.5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Damage per household/farm due to extreme events (e.g., floods, drought)</td>
<td>4.5</td>
<td>4.5</td>
<td>3</td>
<td>5.5</td>
<td>5</td>
<td>4.5</td>
<td>1.5</td>
<td>5.5</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Agricultural contribution to GDP</td>
<td>5.5</td>
<td>4.5</td>
<td>5</td>
<td>2.5</td>
<td>4.5</td>
<td>4.5</td>
<td>5.5</td>
<td>3.5</td>
<td>3.5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Number of jobs created</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>5.5</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

- Carried out with experts in each country during the indicator vetting meetings

- Multi-criteria Ranking of Indicators

- Carried out with experts in each country during the indicator vetting meetings
Salient Results from Indicator Vetting Meetings

- Perfect negative Pearson Rank Correlation between number of practices and number of effectiveness indicators ($p = -1.0$)
- Relatively more policy emphasis in India when compared to other interventions and in other countries
- An agreement among all countries that social indicators are more important than economic or environmental indicators
- The most important criteria for identifying effectiveness indicators in Bangladesh and Nepal was policy relevance (researchers and policy makers) of indicators while in India it was measurability of an indicator
Multi-criteria Analysis: Indicators vs Criteria
From Indicator Vetting Meetings

- There is a large degree of agreement in environmental and economic indicators and high degree of variation in social indicators. Explaining this trend requires further analysis on the contextual background of these study locations (e.g. presence or absence of facilities such as local sanitation, health and education facilities).
Survey Results: Communities

- Climate change as a threat: Majority of respondents have witnessed the increasing drought intensity in their location over the years (80% in Bangladesh).

- Adaptation options: Most important infrastructure, management and policy related adaptation options in Bangladesh were deep tube wells (96%), relay cropping (39%), and credit facilities (39%). In Nepal, they were reported to be water harvesting through ponds (47%), drought tolerant varieties (50%) and crop insurance (50%) respectively. In India, the practices identified were improved irrigation systems and crop insurance.
Survey Results: Communities

- Local effectiveness indicators for assessing the adaptation options: respondents from Bangladesh chose change in groundwater level (91%), calorie intake per person (91%), and % households having access to credit (26%) as the most important (ranked first among a number of indicators; see Figure (4)-4) environmental, social and economic effectiveness indicators of adaptation options they identified above. In Nepal, they were soil organic matter content (50%), number of farmers with concerns related to drought (33%), and crop loss per household due to droughts (25%) respectively for environmental, social and economic effectiveness. In India, the important effectiveness indicators appear to be change in groundwater level, % income used for healthcare, and increase in assets respectively.

- The criteria underlying prioritizing indicators were discussed with the respondents. Simplicity of an indicator was the most important criteria for respondents in Bangladesh and Nepal (22% and 17% respectively).
Major Indicators Prioritized

- Environmental Effectiveness Indicators
  - % of area that have concerns related to Drought
  - Period of fresh water availability
  - Number of droughts
  - Duration of soil cover
  - Soil cover extent (% land covered)
  - Net primary productivity
  - Rise in groundwater level
  - % of farms that have concerns related to soil erosion
  - Organic matter content in the soil
  - Biodiversity (change in species such as bees, natural enemies of pests, birds, frogs etc)
  - Water quality/pollution in ground water
Major Indicators Prioritized

- **Social Effectiveness Indicators**
  - No of farmers with concerns related drought
  - Calorie intake per person
  - Quality of food/Nutritional diversity
  - Access/availability (Number of months of food sufficiency)
  - Affordability to health care
  - Access to healthcare
  - Work load on women (Number of hours spent on labour work)
  - Benefits shared with women (all the other indicators)
  - Women participation in decision making (in village level/groups)
  - % of households having access to information
  - % stunted children
  - % of households having access to safe drinking water
  - Literacy rate
  - Social capital (e.g. household members participation social networks forest user groups, FFS etc)
  - % of households having access to markets
Major Indicators Prioritized

- **Economic Effectiveness Indicators**
  - % of household income from non-agriculture practices
  - Change in household savings/assets
  - Crop yield change (economic terms)
  - Inter-annual variability of household income
  - % of households having access to credit (Formal sector)
  - Crop loss per household due to droughts (in economic terms)
Major Practices Prioritized

- **Infrastructure related options**
  - Irrigation scheduling in the canal
  - Irrigation rationing
  - Community based maintenance of irrigation canals
  - Micro-irrigation systems
  - Water harvesting through ponds
  - Piped irrigation systems
  - Treadle pump/electric pump systems
Major Practices Prioritized

- Management related practices
  - Composting, green manuring, bio-fertilizers for vegetables
  - Mulching for potatoes, sweet potato, pointed guard, asparagus, onions,
  - Zero-tillage, reduced tillage
  - Lime application (Acidity)
  - Drought tolerant varieties in paddy, wheat, local maize
  - Public land agro-forestry with benefit sharing system
  - Spraying of ashes, neem leaf extracts, lemon grass extracts, manual extraction
  - IPM/local practice
  - District agriculture committees for timely input supply
  - Farmer practice of applying fertilizer based on color of leaf
  - Rahat program to provide relieve during drought
Major Practices Prioritized

- Policy and institutional practices
  - Water levy (tax on water)
  - Farmer field schools
  - Migration
  - Micro-enterprise development program
  - Developing non-timber forest produce based livelihood
  - Micro-credit program
  - Cooperatives
  - Crop and livestock insurance program
Adaptation Practices Across Countries

![Graph showing adaptation practices across countries: India, Bangladesh, Nepal. The graph indicates various levels of infrastructure, institutional policy, and management, with distinct colors representing each country.](image-url)
Indicators Across Countries
Project site in Bangladesh

Picture: District level drought hazard maps at 3 months time steps

Source: Shahid et al. 2008
Details of the study sites

District/Zila: Chapai Nawabganj
Sub-district/Upazila: Nachole
Unions: 1) Nachole, 2) Kasba
Villages: Shibpur, 2) Maktapur
3) Shabdalpur, 4) Shonaichondi

Total agricultural land: 28368 ha
Permanent fallow land: 1202 ha
Temporary fallow land: 10 ha
Crop intensity: 212.67%
Number of deep tubewell: 545
Number of shallow tubewell: 70
Number of power pump: 612
Management related Adaptation Options

- Male
  - Adopt drought tolerant crops: 39.2%
  - Short-duration varieties: 39.2%
  - Relay cropping: 26.1%
  - Construction of levee: 19.6%
  - Conversion of agricultural land: 14.4%

- Female
  - Rank 1: 39.2%
  - Rank 2: 29.8%
  - Rank 3: 26.1%
  - Rank 4: 19.6%
  - Rank 5: 15.8%

<table>
<thead>
<tr>
<th>Action</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopt drought tolerant crops</td>
<td>39.2%</td>
<td>39.2%</td>
</tr>
<tr>
<td>Short-duration varieties</td>
<td>39.2%</td>
<td></td>
</tr>
<tr>
<td>Relay cropping</td>
<td>26.1%</td>
<td></td>
</tr>
<tr>
<td>Construction of levee</td>
<td>19.6%</td>
<td></td>
</tr>
<tr>
<td>Conversion of agricultural land</td>
<td>14.4%</td>
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</table>

<table>
<thead>
<tr>
<th>Action</th>
<th>Male</th>
<th>Female</th>
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</thead>
<tbody>
<tr>
<td>Rank 1</td>
<td></td>
<td>39.2%</td>
</tr>
<tr>
<td>Rank 2</td>
<td></td>
<td>29.8%</td>
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<td>Rank 3</td>
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<td>26.1%</td>
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<tr>
<td>Rank 4</td>
<td></td>
<td>19.6%</td>
</tr>
<tr>
<td>Rank 5</td>
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<td>15.8%</td>
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</table>

<table>
<thead>
<tr>
<th>Action</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-duration varieties</td>
<td>24.6%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Relay cropping</td>
<td>29.8%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Construction of levee</td>
<td>22.8%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Homestead Garden</td>
<td>15.8%</td>
<td>10.5%</td>
</tr>
</tbody>
</table>
Gender differentiated ranking

Period of fresh water availability differs significantly by gender (n=197, p = 0.0012, chi-sq = 13.44, df=2)
**Gender sensitive:**

Calorie intake per person (n=208, p=0.031, chi-sq=10.657, df=4) differs significantly by gender

**Gender not sensitive:**

Social capital does not differ significantly by gender
Indicators vs Economic status

Social Indicators

Social capital (n=170, p=0.021, chi-sq=23.948, df=12) differ significantly by economic status.

Economic indicators

Number of jobs created (n=204, p=0.018, chi-sq=30.004, df=16) differ significantly by economic status.
Practice not sensitive

Ranking of the indicators: Period of fresh water availability, and Net primary production does not differ significantly by practice.
Assessing the effectiveness of adaptation practices at the local level through Local Adaptation Index

### Prioritized

<table>
<thead>
<tr>
<th>Indicators (Bangladesh)</th>
<th>Vulnerability</th>
<th>Readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>• % farms with soil degradation (exposure)</td>
<td></td>
<td>• % of households having access to credit (economic)</td>
</tr>
<tr>
<td>• % soil cover (exposure)</td>
<td></td>
<td>• % of households having access to markets (economic)</td>
</tr>
<tr>
<td>• Period of fresh water availability (exposure)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Area under high water use crops (sensitivity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Area under arable farming (sensitivity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Soil organic matter content (capacity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Area under reduced tillage (capacity)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Quantified

<table>
<thead>
<tr>
<th>Indicators (Bangladesh)</th>
<th>Value</th>
<th>Range (Min Max)</th>
<th>Score</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vuln. % Soil degradation</td>
<td>5</td>
<td>5-30</td>
<td>0.17</td>
<td>0.11</td>
</tr>
<tr>
<td>Vuln. % soil cover</td>
<td>70</td>
<td>10-70</td>
<td>1.00</td>
<td>0.11</td>
</tr>
<tr>
<td>Period of water availability (days)</td>
<td>180</td>
<td>50-200</td>
<td>0.90</td>
<td>0.11</td>
</tr>
<tr>
<td>Water int. crops (ha)</td>
<td>30</td>
<td>40-60</td>
<td>0.50</td>
<td>0.11</td>
</tr>
<tr>
<td>Arable farming (ha)</td>
<td>80</td>
<td>40-90</td>
<td>0.89</td>
<td>0.11</td>
</tr>
<tr>
<td>Soil OM content (%)</td>
<td>0.75</td>
<td>0.25-1</td>
<td>0.75</td>
<td>0.11</td>
</tr>
<tr>
<td>Reduced tillage (ha)</td>
<td>40</td>
<td>5-60</td>
<td>0.67</td>
<td>0.11</td>
</tr>
<tr>
<td>Read. Households credit access (%)</td>
<td>50</td>
<td>10-80</td>
<td>0.63</td>
<td>0.33</td>
</tr>
<tr>
<td>Farmers access to markets (%)</td>
<td>60</td>
<td>20-80</td>
<td>0.75</td>
<td>0.33</td>
</tr>
</tbody>
</table>

\[
\text{LaIn} = \left[ \frac{\text{Read} \cdot \left( \frac{\text{Index}_v - \text{Mean}_v(\text{Index})}{\text{Stdev}_v(\text{Index})} \right) \cdot \text{Weight}_v}{\text{Max}(\text{Score})} \right]_{\text{Read.}} \cdot 60 - \left[ \frac{\text{Vuln} \cdot \left( \frac{\text{Index}_v - \text{Mean}_v(\text{Index})}{\text{Stdev}_v(\text{Index})} \right) \cdot \text{Weight}_v}{\text{Max}(\text{Score})} \right]_{\text{Vuln.}} \cdot 40
\]
Use of LaIn in the Gangetic Basin

Checkdams, India

Ground Water Pumping, Bangladesh

Composting, Nepal
Observations from LaIn

- The study is able to identify various agriculture adaptation effectiveness indicators for the first time in the Gangetic Basin.
- ~65% similarity in indicators identified between bottom-up (LaIn) and top-down approaches (GaIn)
- Relatively more policy emphasis in India when compared to other interventions and in other countries
- An agreement among all countries that social indicators are more important than economic or environmental indicators
- The most important criteria for identifying effectiveness indicators in Bangladesh and Nepal was policy relevance (researchers and policy makers) of indicators while in India it was measurability of an indicator
- The LaIn is able to show sensitivity to different agriculture practices tested in three locations in the Gangetic Basin.
Significance of the Study

- The study was able to identify location specific indicators for measuring effectiveness of actions at local level for the first time in the Gangetic Basin.
- The Local Adaptation Index (LaIn) will be able to help local governments and project managers to narrow down the adaptation options at the local level.
- The index is currently tested for drought conditions. FYIV will focus on testing it for flood conditions.
Prioritizing Adaptation Options

Bottom-up process using analytical hierarchy process (AHP) at the same study locations as top-down indicators
Qualitative Approach using AHP for Prioritizing Adaptation Options
Steps Involved in AHP through FGDs

- Identify locations for conducting FGDs with local consultation (presence of adaptation practices)
- Indicator vetting through Participatory Rural Appraisal Processes
- Identify discussants representing the socio-economic composition of the village in which FGDs are conducted
- Introduce the purpose of the discussion
  - Demographics and identification of past climatic impacts
- Identification and ranking of practices based on how they were effective in minimizing the impacts, identify and rank indicators and criteria
- AHP process: Pairwise comparison of criteria, indicators and practices
- Windup the discussion
- Consolidate the results to compare indicators and practices across locations
Survey methodology cont...

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampled villages</td>
<td>Two villages in drought-prone area and two villages in flood-prone area of Bangladesh, India and Nepal</td>
</tr>
<tr>
<td>FGD Sub-groups</td>
<td>One male and one female FGD per village</td>
</tr>
<tr>
<td>Number of participants per FGD</td>
<td>10-28 depending on the size of the village following a thumb-rule of 10% of households to be sampled.</td>
</tr>
<tr>
<td>Characteristics and respondent selection</td>
<td>Participants of each gender based sub-group is selected in a stratified random sample i.e. representing economic and educational classes representing each village</td>
</tr>
</tbody>
</table>
## Study locations

<table>
<thead>
<tr>
<th>Country</th>
<th>Drought-prone area</th>
<th>Flood-prone area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>Maktapur, Chapainawabganj district (10 male and female)</td>
<td>Soankandi, Chapainawabganj district (10 male and female)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>Selhupur, Kanpur Dehat district (11 male and female)</td>
<td>Salarpur, Kanpur Dehat district (8 male)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nepal</td>
<td>Fattepur, Birganj district (23 male and 25 female)</td>
<td>Bageshwori, Birganj district (28 male and 25 female)</td>
</tr>
</tbody>
</table>
### Saaty’s Fundamental Scale of Judgment

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance</td>
<td>Judgment slightly favors one criteria over another</td>
</tr>
<tr>
<td>5</td>
<td>Strong importance</td>
<td>Judgment strongly favors one criteria over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>A criteria is favored very strongly over another</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>Judgment favoring a criteria is of the highest possible order of affirmation</td>
</tr>
</tbody>
</table>
Decision Hierarchy Tree: Nepal – drought -male

Goal: Reduce drought sensitivity and improve adaptive capacity

Criteria:
- Bring effect on policy: 0.78
- Replicable: 0.11
- Easy to see the benefit: 0.11

Indicators:
- Availability of water: 0.65
- Increase in crop yield: 0.18
- Escape drought: 0.09
- Cost effectiveness: 0.03
- Less investment: 0.05

Practices:
- Pump for groundwater: 0.39
- Harvesting surface water: 0.38
- Pest Control: 0.06
- Alternative Crops: 0.06
- Drought resistance varieties: 0.12
Nepal – drought -male

Aggregated score of adaptation practices and their composition

- Drought resistant varieties
- Alternative crops
- Pest control
- Harvesting surface water
- Pump for groundwater

Availability of Water
Increase in Crop Yield
Escape drought
Cost effectiveness
Less investment

Cost effectiveness
Decision Hierarchy Tree: Bangladesh – flood-female

Reduce flood sensitivity and improve adaptive capacity

Cost effectiveness
- Increase in yield: 0.14

Communicability
- Increase in income: 0.14

Balanced nutrition
- Improved communication: 0.27

Relates to alternative income
- Homestead elevation: 0.34

Modern ag. knowledge
- Income diversification: 0.10

Embarkment
- Cost effectiveness: 0.04

Communicability
- Relates to alternative income: 0.18

Income diversification
- Modern ag. knowledge: 0.12

Embarkment
- Communicability: 0.78

Balanced nutrition
- Embarkment: 0.77

Cost effectiveness
- Modern ag. knowledge: 0.12

Communicability
- Communicability: 0.78

Balanced nutrition
- Communicability: 0.78
Case 2: Bangladesh – flood-female

Income diversification

Embarkment

Modern agriculture knowledge

Increase in yield
Increase in income
Improved communication
Balanced nutrition
Homestead elevation

58
Adaptation Effectiveness: Male FGDs

- **Land leveling**
- **Bore well**
- **Ground water**
- **Canal irrigation**
- **Resistant varieties**
- **Ground water**
- **Crop rotation**
- **Farm ponds**
- **River embankment**
- **Desilting**
- **Drainage**
- **Early warning**
- **Embarkment**
- **Lifesaving activities**
- **Embarkment**
- **Seasonal migration**
- **Women employment**

Country Distribution:
- **India**
- **Nepal**
- **Bangladesh**

**Drought prone areas**

**Flood prone areas**

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## Adaptation Effectiveness: Female FGDs

<table>
<thead>
<tr>
<th>Practice</th>
<th>India</th>
<th>Nepal</th>
<th>Bangladesh</th>
<th>Nepal</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore well</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Land leveling</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Resistant varieties</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Ground water</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Surface irrigation</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>Green manures</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Ground water</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Mini pond</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
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<tr>
<td>Crop rotation</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
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<td>0.30</td>
</tr>
<tr>
<td>Livestock evacuation</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
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<tr>
<td>Evacuation of assets</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>River embankment</td>
<td>0.00</td>
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<tr>
<td>Embankment</td>
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<td>0.00</td>
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<td>0.00</td>
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<tr>
<td>Modern agriculture</td>
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<tr>
<td>Income diversification</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

**Drought prone areas**

- Bore well
- Land leveling
- Resistant varieties
- Ground water
- Surface irrigation
- Green manures
- Ground water
- Mini pond
- Crop rotation

**Flood prone areas**

- Livestock evacuation
- Evacuation of assets
- River embankment
- Embankment
- Modern agriculture
- Income diversification
Key findings

– Considerable variation from community to community

– **In drought-prone areas**, boring wells were generally preferred over surface water. Water-saving activities such as change in cropping pattern and organic farming were also preferred.

– **In flood-prone areas**, saving assets/lives through embankment, as well as access to alternative employment also preferred.

– Limited but visible difference identified between male and female groups
Role of AHP to identify priority actions

• AHP can reveal the decision-making process, identify priority actions, and also suggest adaptation indicators.
• However, pairwise ranking process can be time consuming and difficult to be understood.
• AHP more understood in relatively well-educated community.
• Clear incentives (e.g. possibility of project funding) desirable to engage community members.
Way Forward

- There are significant gaps in the institutional capacities for implementing the methodology developed in this research and hence need to be bridged.

- Assist National Bank for Agriculture and Rural Development (NABARD) of India, through Adapt-Asia and USAID, the national implementation agency for Adaptation Fund, in development VCA methodology for Adaptation Fund projects in India.
Recent Reports


- Prabhakar et al., adaptation effectiveness indicators in Gangetic Basin, 2013. IGES研究報告書2013-02、地球環境戦略研究機関（IGES）（神奈川県葉山町）
Thank You!
prabhapkar@iges.or.jp