Improving the climate resilience of small and medium scale irrigation
<table>
<thead>
<tr>
<th>Time</th>
<th>Topics / Activities</th>
<th>Resource Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00–09.30</td>
<td>Registration and Tea / Coffee</td>
<td></td>
</tr>
<tr>
<td>09:30 –09:50</td>
<td>Welcome address and brief on DOI-CDKN research on “Framework for effectiveness and resilience of irrigation in Nepal”</td>
<td>DOI</td>
</tr>
<tr>
<td>09:50 - 10.15</td>
<td>Introduction to the study: concept and approach</td>
<td>Simon Howarth</td>
</tr>
<tr>
<td>10.15 - 10.40</td>
<td>Climate change in Nepal: future scenarios</td>
<td>Dr. Keshav Sharma</td>
</tr>
<tr>
<td>10.40 – 11.05</td>
<td>Climate change and impact on irrigation</td>
<td>Dr. Umesh Parajuli</td>
</tr>
<tr>
<td>11:05 – 11.30</td>
<td>Review of Design of Small and Medium Irrigation Projects in DoI</td>
<td>Binay Koirala</td>
</tr>
<tr>
<td>11.30 – 11.45</td>
<td>Tea break</td>
<td></td>
</tr>
<tr>
<td>11.45 – 12.10</td>
<td>Research methods, schedules, and expected outputs</td>
<td>Dr Prachanda Pradhan</td>
</tr>
<tr>
<td>12.10 – 13.10</td>
<td>Discussions</td>
<td>Simon Howarth</td>
</tr>
<tr>
<td>13.20 – 13.30</td>
<td>Remarks from DDG and DG</td>
<td></td>
</tr>
<tr>
<td>13.30</td>
<td>Lunch</td>
<td></td>
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</tbody>
</table>
Introduction to the study: concept and approach

Simon Howarth
Objectives

• Improve the approach and methodology for planning and delivery of efficient, effective, equitable and climate-resilient irrigation systems.

• Assess processes, institutions and policy for irrigation development, management and resource governance.

• Provide framework to increase the climate resilience and effectiveness of small and medium scale irrigation systems.

• Ensure framework is well understood by the relevant governing and implementing parties.
What does this really mean?

• We need to understand the range of changes to the climate that may occur in different contexts, and their hydrological impact.

• We need to cope with uncertainty, to understand the risks and consequences of failure and to develop a sensible approach which is both affordable and safe, as well as adaptable.

• A lot of the measures for this are already known – current best practice promotes resilience – but there are additional risks, so new analysis and solutions are needed.

• The framework and guidelines must be pragmatic and simple to use, and written in language that practitioners are familiar with.
The Team

- **Mott Mac Donald**
  - Simon Howarth: Irrigation
  - Kiki Pattenden / David Viner: Climate Science/Hydrology
  - Marieke Nieuwaal / Zhang Yi: Water resource management

- **FMIST**
  - Prachanda Pradhan: Social/Institutional development
  - Sushil Subedi: Sociologist

- **ADAPT-Nepal**
  - Keshav Sharma: Hydrology

- **CERD**
  - Dr Umesh Parajuli: Irrigation Management
  - SK Uphadhyaya: Agriculture
  - SK Uphadhyaya: Economics
Components to the study

- Climate assessment
- Field studies – perceptions, problems, risks, vulnerability
- Global literature review
- Sectoral analysis
- Synthesis
- Overall framework for resilience
- Technical outputs and briefing documents

Consultation and capacity-building integrated into the study, at all stages
Inception Phase

- Identification and initial consultations with major stakeholders involved in irrigation and irrigated agriculture;
- Initial review of climate models and scenarios, main changes anticipated in various zones
- Inventory of irrigation systems, review of irrigation typology
- Plan for main phase of study
Irrigation in Nepal

Economic Impact Assessment of Climate Change in Key Sectors in Nepal

Table 2.1. Agricultural Production – Main Production (2012/13)

<table>
<thead>
<tr>
<th>AEZ</th>
<th>Total Irrigable Area</th>
<th>Major &amp; Large Surface Irrigation</th>
<th>Total Small and Medium (AMIS+FMIS incl. GW)</th>
<th>TOTAL Irrigated Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FMIS, AMIS, Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarai</td>
<td>1,337,581</td>
<td>36,300, 280,933, 317,233</td>
<td>677,764</td>
<td>994,997</td>
</tr>
<tr>
<td>Hills</td>
<td>368,541</td>
<td>2,630, 2,910, 5,540</td>
<td>176,774</td>
<td>182,314</td>
</tr>
<tr>
<td>Mountain</td>
<td>59,718</td>
<td>50,042</td>
<td>50,042</td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>1,765,840</td>
<td>38,930, 283,843, 322,773</td>
<td>904,580</td>
<td>1,227,353</td>
</tr>
<tr>
<td>% total irrigated area</td>
<td></td>
<td>3%, 23%, 26%</td>
<td>74%</td>
<td>100%</td>
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</tbody>
</table>
# Small and Medium Irrigation

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<tr>
<th>AEZ</th>
<th>Surface irrigation</th>
<th>Groundwater</th>
<th>Non-conv.</th>
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<tr>
<td></td>
<td>FMIS</td>
<td>AMIS</td>
<td>STW (FMIS)</td>
<td>DTW (AMIS)</td>
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<tr>
<td>Tarai</td>
<td>379,884</td>
<td>14,765</td>
<td>239,326</td>
<td>38,100</td>
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<tr>
<td>Hills</td>
<td>155,654</td>
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<td>732</td>
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<tr>
<td>Mountain</td>
<td>47,195</td>
<td>1,860</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>582,733</td>
<td>30,678</td>
<td>240,058</td>
<td>38,100</td>
</tr>
<tr>
<td>% total area</td>
<td>64%</td>
<td>4%</td>
<td>31%</td>
<td>1%</td>
</tr>
<tr>
<td>% in each AEZ</td>
<td>65%</td>
<td>48%</td>
<td>64%</td>
<td>100%</td>
</tr>
<tr>
<td>Tarai</td>
<td>27%</td>
<td>46%</td>
<td>28%</td>
<td>0%</td>
</tr>
<tr>
<td>Hills</td>
<td>8%</td>
<td>6%</td>
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[Source: Mott MacDonald]
Next Steps

- Detailed review of future climate scenarios
- Global Literature review
- Compilation of secondary data on irrigation systems
- Sector analysis
- Field studies – programme to be confirmed
- Synthesis of field studies with data, literature and consultations to develop implementable recommendations;
- Communication and dissemination strategy.
Climate change in Nepal: future scenarios

Dr Keshav Sharma
Climate change and Impact on Nepal
Irrigation

Dr Umesh Parajuli
Climate change and its consequences

Climate Change

Changes in Temperature

Intensify hydrological cycle

Changes in ET$_0$ and biomass production

Changes in precipitation

Changes in seasonal water availability

Impact on Irrigation
Change in temperature

- Warming rate in Nepal is greater than global average
- Past trend of warming: 0.4°C to 0.6°C per decade.
- This trend is expected to be intensified in future

Projected mean annual temperature
(15 models and 3 Scenarios)

Mean Annual Temperature is expected to increase by 2 to 5 °C by the end of this century.
Changes in rainfall

- No defined past trends in rainfall pattern.
- Past data show large inter-annual variability.

Projected Annual Precipitation
(15 models and 3 Scenarios)

Level of uncertainty in future projections of precipitation is high due to methods of modelling, downscaling and locations, and vertical dimension etc.
# Impacts: increase in temperature

<table>
<thead>
<tr>
<th>Impact</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative impact</strong></td>
<td>1. Evapo-transpiration will increase (every 1°C rise in temp. will increase $ET_{\text{crop}}$ by 6-7 %)</td>
</tr>
<tr>
<td></td>
<td>2. Loss of some plant varieties due to inability to cope with rising temperature</td>
</tr>
<tr>
<td><strong>Positive impact</strong></td>
<td>1. Biomass production and consequently crop yield will increase</td>
</tr>
<tr>
<td></td>
<td>2. Cultivation can be possible even in higher altitude</td>
</tr>
</tbody>
</table>
Changes in precipitation: One scenario

1. Rainfall will be more erratic and intensified
2. More precipitation will fall as rainfall than snow
3. Snow melt will start earlier
4. Winter season will be shortened
5. Number of consecutive dry days per year will increase

Threats: Changes in water demand & availability; drought
6. Peak river flood flows may occur earlier (shifting of monsoon), and may increase.

7. Pre-monsoon river flow (May- June) may increase

8. Low flows in rivers (Nov.-March) may decrease

Threats: Floods and changes in water availability
## Climate Change threats & impacts

<table>
<thead>
<tr>
<th>Threats</th>
<th>Impacts</th>
<th>What shall we do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooding and flash floods</td>
<td>1. Physical damage of infrastructure</td>
<td>1. Re-visit flood design parameters? (design assumptions, flood assessment methods, return period etc)</td>
</tr>
<tr>
<td>(Due to increased &amp; erratic rainfall and GLOFs)</td>
<td>2. Inundation &amp; sedimentation in canals</td>
<td>2. Introduce new design concepts? (design to fail, safety embankment, more flexible or robust design etc)</td>
</tr>
<tr>
<td></td>
<td>3. Increased destabilization of nearby land</td>
<td>3. Any other proposal?</td>
</tr>
<tr>
<td></td>
<td>4. Erosion, landslides</td>
<td></td>
</tr>
</tbody>
</table>

Mott MacDonald
## CC threats & impacts

<table>
<thead>
<tr>
<th>Threats</th>
<th>Impacts</th>
<th>What shall we do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in seasonal water availability and frequency of drought</td>
<td>Increasing trend of water availability (pre-monsoon)</td>
<td>Potentially a positive impact – good for irrigated paddy. during pre-monsoon, but also risks for winter:</td>
</tr>
</tbody>
</table>
|                                              | Decreasing trend of water availability in rivers (Nov –March) leading to long dry spell and drought – may impact the vision of perennial irrigation | 1. Diversification of water sources  
2. Adopt new management options to increase irrigation efficiencies  
3. Reduce irrigated area  
4. Initiate cultivation of low water demanding crops  
5. Introduce intermediate water storage  
6. Initiate deficit irrigation |
## CC threats & impacts

<table>
<thead>
<tr>
<th>Threats</th>
<th>Impacts</th>
<th>What shall we do?</th>
</tr>
</thead>
</table>
| Change in seasonal water availability and drought | Fluctuating trend of water availability in rivers - mainly in the monsoon season – leading to (a) intermediate long dry spell, and (b) an issue of reliability of flows | 1. Revisit design assumptions (80% reliable flow)  
2. Increase free board in the canal (in AMISs) to allow transport of extra water when available.  
3. Introduce intermediate water storage  
4. Initiate deficit irrigation  
5. Use of tube wells for conjunctive uses in terai |
### Issue 1: Nepal’s Irrigation systems, are they resilient to Climate Change?

<table>
<thead>
<tr>
<th>SN</th>
<th>System types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tube well irrigation</td>
</tr>
<tr>
<td>2</td>
<td>Run-off-the river systems receiving waters from the tributaries of major rivers</td>
</tr>
<tr>
<td>3</td>
<td>Run-off-the river systems receiving waters from major rivers or reservoir (Mahakali, Gandak, Fewa, Begnas etc)</td>
</tr>
<tr>
<td>4</td>
<td>Supplementary irrigation systems (surface)</td>
</tr>
<tr>
<td>5</td>
<td>Non-conventional irrigation systems: Drip, sprinkler, tank</td>
</tr>
<tr>
<td>6</td>
<td>Present design of surface irrigation system (structured irrigation system)</td>
</tr>
</tbody>
</table>
Issue 2: DOI’s ongoing small & medium scale IDP: are they resilient to CC?

- Irrigation sector projects (IWRMP  CMIASP-AF)
- Medium irrigation projects
- Non-conventional irrigation development program
- Tubewell irrigation (shallow / deep)

- Are these projects resilient to climate change?
- If not, what needs to be done in making them resilient to climate change?
Review of Design of Small and Medium Irrigation Projects in Dol

Vinay Koirala
Schedule and outputs, research methods,

Simon Howarth
Prachanda Pradhan
Plan of Activities - 1

- **Inception (Mar-April)**
  - Detailed planning, stakeholder analysis and consultations

- **Interim Assessment (May-December)**
  - Review and assessment of irrigation sector
  - Assess existing evidence on impacts of climate change on irrigation systems and users, and responses to climate
  - Climate review, and impact on irrigation design parameters
  - Fieldwork (monsoon 2015 – *to be confirmed*) on representative systems (small and medium scale)
Analysis and Synthesis (Jan – Jun 2016)

- Continued fieldwork (winter/spring 2015/16)
- Synthesis of survey results with secondary data and other project findings
- Assessment of potential interventions for coping with climate change and variability in the irrigation sector
- Preparation of initial technical guidance documents
Outputs

- Final report and dissemination (July-December 2016)
  - Preparation of framework for climate resilient pro-poor irrigation
  - Identification and documentation of policy and technological best practices/interventions
  - Preparation and dissemination of a range of technical outputs
Irrigation strategy, policy

Irrigation programmes

Climate change scenarios

Other studies and programmes

National overview of Sector
irrigation performance and climate vulnerability

Irrigation database and sampling

Study: local details and perceptions. Current performance and trends

Interim report and framework
Options, best practices and gaps in knowledge

Study: Current performance, practices, institutions, influences, variability and trends

Consultations and Capacity Building

Estimated range of climate variability at local level

Field Study Monsoon 2015

Integration of Field and Desk studies

Field Study Spring 2016

Finalisation

Irrigation Master Plan (in prep.)

Final framework

Design Guidelines (requested)

Mott MacDonald
Field Research Methods - Introduction

• Vulnerability to climate change and ability to adapt to it is dependent on local context
• The study about the resilience of irrigation needs to be firmly grounded in an understanding of the local situation
Methods adopted to understand local situation

- **Desk Study**
- Irrigation and Climate change literature review. 72 international papers and 62 Nepal-related publications have been collected and put it for quick reference in the Dropbox.
- Additional papers being collected, and literature review in preparation
Field work

- A limited program of field work will be undertaken during this study.
- The field work will provide understanding of the issues related to climate resilience in representative locations.
- The information thus collected will be analysed and synthesized with secondary and national data.
Selection of sub-basins and irrigation systems for study

- A basin in western Nepal covering hill and Tarai such as West Rapti Basin would be the preferred selection for detail study.

- Sub-basins like Marin Khola (Bagmati basin, Central Region) and Kamala Basin (eastern region) will be the subject of reconnaissance visit.
• On the basis of reconnaissance visit (detail checklist is prepared) to these sub-basins during monsoon 2015,
• Selection of the irrigation systems for detail investigation in Spring season will be made
• Based on this study, necessary adjustment will be made to make the study more representative (the study will focus on medium and small irrigation systems)
Case study Analysis

- Prepare a simple report on each system (based on checklist)
- Summarize observations and findings
- Further information on perception of climate change, risk, vulnerability and ability to cope will be collected
Gaps in Knowledge and Coping Strategy

- Measures needed for adaptation
- Institutional arrangements for implementation of potential measures
- Impacts and risks
• Field data
• Sector analysis and secondary data
• Climate review, risk assessment and design parameters
• Bring together to recommend resilient approaches