To Participants from

Environmental Impacts of Irrigation

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Contents

✓ What is Environment?
✓ Definition of Irrigation
✓ Evolution of Water Resources of AP
✓ Environmental Impact of Irrigation
✓ EIA & EMP for Irrigation Projects
What is Environment?

- **Geographical Environment**
  - Natural Resources, Earth’s surface, Mountains, Plains, Land, Rivers, Oceans, Deserts, Climatic Factors, Storms, Cyclones, Monsoon, Volcanoes

- **Man-made Environment**
  - **Socio (inner Environment)**
    - Regulations, Traditions, Organizations and Institutions
  - **Cultural (Outer Environment)**
    - Modern infrastructure, our homes and their associated amenities, modes of communication and transport, different kinds of industry manufacturing luxurious commodities, electrical appliances which ultimately aims at civilization and urbanization.
What is Irrigation?

The Process of Collecting, Storing, Diverting, Transporting, Supplying to Crops, Consuming, and Draining the water.

Why Irrigation?

To meet the Food grain demand (for consumption) of growing Population.
Six thousand years ago farmers in Mesopotamia started diverting water from the Euphrates River. Thus, Sumerians went on to form the world's first irrigation-based civilization.

Sumerian farmers harvested plentiful wheat and barley crops for some 2,000 years, but the soil eventually succumbed to salinization.

Many historians argue that soil salinization and the decline in food supply figured prominently in the society's decline (Eg: Sumeria)
Water availability and demand (INDIA)

Water Availability
On decline

66000 TMC
Water Availability

WORLD WIDE

108000 Cubic km Precipitation

47000 cubic km Surface water

11000 cubic km Accessible water

3400 cubic km available water

70% of it utilized for Irrigation
Population and Water Sufficiency

World Population in Billion

- 1880: 1.60
- 1900: 2.50
- 1920: 6.00
- 1940: 7.82
- 1960: 9.00
- 2000: 7.82 billion
- 2020: 9.00
- 2025 (medium projection): 7.82 billion

- Relative Sufficiency: 92%
- Stress: 3%
- Scarcity: 5%

7.82 Billion by 2025
Developed countries, on average, irrigated 10% of their agricultural area, and countries in development 23%, and combined they irrigated 18% of the total agricultural area.

United Nation’s predictions of global population increase to the year 2025 require an expansion of food production of about 40-45%.
Food Grain Productivity

<table>
<thead>
<tr>
<th>S.No</th>
<th>Year</th>
<th>All India Production</th>
<th>A.P Production</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2007-08</td>
<td>230.78</td>
<td>19.82</td>
<td>8.6</td>
</tr>
<tr>
<td>2</td>
<td>2008-09</td>
<td>234.47</td>
<td>20.42</td>
<td>8.7</td>
</tr>
<tr>
<td>3</td>
<td>2009-10</td>
<td>218.20</td>
<td>* 15.60</td>
<td>7.1</td>
</tr>
<tr>
<td>4</td>
<td>2010-11</td>
<td>235.88</td>
<td>20.31</td>
<td>8.6</td>
</tr>
<tr>
<td>5</td>
<td>2011-12</td>
<td>250.42</td>
<td>18.40</td>
<td>7.3</td>
</tr>
<tr>
<td>6</td>
<td>2012-13</td>
<td>250.42</td>
<td>18.74</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2013-14</td>
<td></td>
<td>11.70</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2014-15</td>
<td>250.00</td>
<td>11.78</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2015-16</td>
<td>252.22</td>
<td>14.38</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2016-17</td>
<td></td>
<td>14.92</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2017-18</td>
<td></td>
<td>16.72</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2049-50</td>
<td>450.00</td>
<td>35.00</td>
<td></td>
</tr>
</tbody>
</table>
Irrigation as Source of Environmental Impact

✓ Construction of Irrigation Projects

Irrigation represents an alteration of the natural conditions of the landscape by extracting water from an available source, adding water to fields and introducing man-made structures and features to extract, store, transfer and dispose of water.

✓ Water Supply and Operation of Irrigation Projects

✓ Irrigated Agriculture Management Practices.

The benefits of irrigation have resulted in lower food prices, higher employment and more rapid agricultural and economic development.
Evolution of Water Resources

- Tanks: 40,000
- Barrages: 4
- Gravity based Reservoirs: 115
- Lift systems: 350
- Micro Irrigation
- Inter Linking

Environmental Impacts of Irrigation
Prakasam Barrage
- Constructed: 1852/1957
- Capacity: 3.07 TMC

Pulichintala Project
- Constructed: 2014
- Capacity: 45.77 TMC

NSP
- Constructed: 1967
- Capacity: 408 TMC

Srisailam Dam
- Constructed: 1980
- Capacity: 216 TMC

Jurala Project
- Constructed: 1981
- Capacity: 11.20 TMC

Narayanapur Dam
- Constructed: 1982
- Capacity: 37.965 TMC

Almatti Project
- Constructed: 2005
- Capacity: 123 TMC

KARNATAKA

TELANAGANA

ANDHRA PRADESH

TOTAL LENGTH OF KRISHNA RIVER: 1400KM

ENVIRONMENTAL IMPACTS OF IRRIGATION
Between 1857-2019
About 70 Major & Medium Irrigation Projects are Constructed and about 1 Cr Acres of Land is brought under Irrigation
Godavari Basin Projects

Jaikwadi Project
Constructed: 1976
Capacity: 102.7 TMC

Pochampad Project
(Sri Ram Sagar)
Constructed: 1975
Capacity: 90.3 TMC

Dowlaiswaram Barrage (SACB)
Constructed: 1850
Rebuilt in: 1970
Capacity: 2.93 TMC

TOTAL LENGTH OF GODAVARI RIVER: 1465KM
Existing Scenario (2019)

- **Total Geographical Area**: 402 Lakh Ac
- **Cultivable Area**: 199 L Ac
- **Localised Command area**: 103 lakh Ac
- **Irrigation Facility to about**: 80 lakh Ac

**WATER STORAGE ZONE**

- **Normal to high Rainfall (south west)**: 50% of Irrigated area
- **Normal to Less Rainfall (NE Monsoons)**: 30% of Irrigated area
- **High rainfall**: 20% of Irrigated area

**ENVIRONMENTAL IMPACTS OF IRRIGATION**
## Area Irrigated in 2017 kharif

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of irrigation</th>
<th>Ayacut Proposed (Lakh Ac)</th>
<th>Ayacut Irrigated (Lakh Ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water</td>
<td>Major and Medium irrigation</td>
<td>66.88</td>
<td>43.41</td>
</tr>
<tr>
<td></td>
<td>Minor irrigation including lift</td>
<td>25.38</td>
<td>15.09</td>
</tr>
<tr>
<td></td>
<td>Surface Irrigation</td>
<td>92.26</td>
<td>58.50</td>
</tr>
<tr>
<td>Groundwater</td>
<td></td>
<td>23.44</td>
<td>23.22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>115.70</strong></td>
<td><strong>81.72</strong></td>
</tr>
</tbody>
</table>
Krishna Delta System – Evolution (1791-2019)

Flows at Prakasam Barrage between 1957-2017

ENVIRONMENTAL IMPACTS OF IRRIGATION
Basins and Availability of Water

<table>
<thead>
<tr>
<th>Basin</th>
<th>Availability (TMC)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krishna</td>
<td>532.04</td>
<td>29%</td>
</tr>
<tr>
<td>Godavari</td>
<td>860.00</td>
<td>47%</td>
</tr>
<tr>
<td>Pennar</td>
<td>98.65</td>
<td>5%</td>
</tr>
<tr>
<td>Vamsadhara</td>
<td>52.50</td>
<td>3%</td>
</tr>
<tr>
<td>Others</td>
<td>289.90</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1833.09</strong></td>
<td></td>
</tr>
</tbody>
</table>
Water Availability Usage and New requirements

800 TMC Allocated

- Krishna delta 180 TMC
- Nagarjuna Sagar Project 164 TMC
- Kurnool-Kadapa Canal 40 TMC
- TBP HLC 32.50 TMC
- TBP LLC 24 TMC
- Bhairavanitippa 4.9 TMC
- Guntur Channel 4.0 TMC
- Vaikuntapuram 2.6 TMC
- Gajuladinne 2 TMC
- Godavari Delta System 250 TMC
- Vamsadhara 50 TMC

Addl Requirement 350 TMC

- Polavaram 200 TMC
- HNSS 40 TMC
- GNSS 40 TMC
- TGP 30 TMC
- Veligonda 40 TMC

ENVIRONMENTAL IMPACTS OF IRRIGATION

800 TMC Allocated
New Adage and Approach

Driving Philosophy is “WATER SECURITY” TO ALL STAKE HOLDERS

1. Achieving Water Use Efficiency in existing Projects
2. Water Conservation/harvesting
3. Transfer of Water from Surplus to deficit regions through Interlinking across basins

ENVIRONMENTAL IMPACTS OF IRRIGATION
Realtime water availability

ENVIROMENTAL IMPACTS OF IRRIGATION
Major Activities in Irrigation

1. Planning
2. Investigation
3. Estimating & Costing
4. Designs
5. O & M
6. Construction

Stake Holders
- Citizens
- Farmers
- Industries
- Aquafarms
- APWRD
- Government
Study of the earth and its features and phenomena. A literal translation would be "to describe or write about the Earth".

Obtaining and generation of useful data like maps, images, statistical graphics, tables related to geographical features.

Organizing the above data with functional capabilities for data capture, input, query, analysis, modeling, visualization and web access.
# Environmental Impacts of Irrigation

## Direct Effects
- Construction of Irrigation structures
- Change in Hydrological features
- Reduction in D/S Water flow
- Occurrence of Floods and Droughts
- Groundwater recharge/pumping
- Land use changes
- Soil erosion
- Agricultural scenario
- Increased Evaporation

## Indirect Effects
- Waterlogging
- Soil Salinization
- Ecological damage
Change in the Hydrological features....

Irrigation schemes alter the natural hydrological features of a location and lead to changes in the natural quality of soil and water in the region where it is applied.

Reduction in D/S water flow (Prakasam Barrage)

Due to introduction of 8 reservoirs
Reduction in D/S water flow (eg...Prakasam Barrage)
Prakasam Barrage
Constructed: 1852/1957
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TOTAL LENGTH OF KRISHNA RIVER: 1400KM

ENVIRONMENTAL IMPACTS OF IRRIGATION

Riverine Floods 2019
Krishna Basin Projects

TELANAGANA

ANDHRA PRADESH

Affected areas
Riverine Floods 2019

Inundation (Google Map)
Riverine Floods 2019

Inundation (SI Map)
Rescue and Rehabilitation

Kallamvaripalem (Krishna district)
Vellaturu-Kishkindhapalem (Guntur District)
Construction of Irrigation Projects

Irrigation represents an alteration of the natural conditions of the landscape by extracting water from an available source, adding water to fields and introducing man-made structures and features to extract, transfer and dispose of water.

Water supply and operation of irrigation projects

- Increase in irrigation area and water withdrawals
- Use of unlined irrigation canals

Irrigated agriculture management practices

The benefits of irrigation have resulted in lower food prices, higher employment and more rapid agricultural and economic development.
Construction of Irrigation Projects
And Environmental Impact

✓ Before 1900 only 40 reservoirs had been built with storage volumes greater than 25 billion gallons

✓ Today almost 3,000 reservoirs larger than this inundate 120 million acres of land and hold more than 1,500 cubic miles of water

✓ The results are clear that dams have destroyed the ecosystems in and around countless rivers, lakes and streams.

✓ More than 900 dams on New England and European rivers block Atlantic salmon (King of Fish) from their spawning grounds and their populations is diminished.
Operation Of Irrigation Projects VS Environmental Impact

✓ Withdrawing ground-water may cause the land to subside, aquifers to become saline and other types of ground-water pollution.

✓ Surface water usage changes to the natural hydrology of rivers and water streams, affecting the aquatic ecosystems.

✓ For example, The Colorado River doesn't make it to the ocean, owing to both urban and agricultural withdrawals in Mexico and affecting its riparian ecosystems, delta and estuary system at its mouth.

✓ Groundwater is being mined. In India's Punjab, pumping exceeds recharge by 1/3, causing water tables to drop by 1 m/yr or more.
Irrigated Agriculture Management Practices

VS

Environmental Impact

- Waterlogging
- Salinization (Water & Soil)
- Erosion of irrigated areas
- Downstream degradation of water quality by salts
- Agrochemicals and Toxic Leachates is a serious environmental problem.
Other Factors as part of Irrigation

✓ extensive monoculture and excessive use of persistent pesticides
✓ increased salinization and salt runoff leading to salinization of major rivers
✓ Discharge of highly mineralized, pesticide-rich return flows to main rivers, and excessive use of fertilizers
✓ Constraints in the water delivery systems (e.g., continuous versus on-demand water supply)
✓ Extremely low water quality of the irrigation water supply
✓ limitations to investment on improved technologies exacerbate the environmental damage derived from irrigation
Soil Salinity: Sources and Processes

- Old geologic layers, sea salt transported by rain and wind, salty-groundwater discharge, irrigation, and etc.
- Naturally occurring (primary) processes: marine plains and salt lakes.
- Human-induced (secondary) processes: dryland salinity and irrigation salinity.

(Source: CSIRO Land and Water, 1999)
Soil Salinity: Definition and Measurement

Water salinity

- The amount of salt contained in the water.
- Expressed in grams of salt per litre of water (g/l ~ per mil, ppt).
- Measured by an electrical device (1 g/l ~ 1.5 mmhos/cm = 1.5 dS/m).

Soil salinity

- The amount of salt contained in the soil.
- Extraction method:
  - Soil sample is saturated and left for 48 hours;
  - Moisture is extracted in a vacuum chamber and conductivity of the solute is measured.
- 1:5 Solution method:
  - Soil sample is mixed with water in a 1:5 ratio by weight;
  - Conductivity of the solution is measured.

<table>
<thead>
<tr>
<th>Salinity level</th>
<th>g/l</th>
<th>dS/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-saline</td>
<td>0 – 3</td>
<td>0 – 4.5</td>
</tr>
<tr>
<td>Slightly saline</td>
<td>3 – 6</td>
<td>4.5 – 9</td>
</tr>
<tr>
<td>Medium saline</td>
<td>6 – 12</td>
<td>9 – 18</td>
</tr>
<tr>
<td>Highly saline</td>
<td>&gt; 12</td>
<td>&gt; 18</td>
</tr>
</tbody>
</table>

(Source: FAO Natural Resources Management and Environment Department)
Soil Salinity: Salt-Affected Areas

✓ 7% of the earth’s continental extent
✓ 20% of the world’s irrigated lands
✓ Reduced crop productivity, soil degradation, increased soil erosion, and etc.
✓ Estimated damage of $208 million (USD) in the Murray Darling Basin by human-induced salinization.

Salt-affected areas of the world (> 10 Mha)

<table>
<thead>
<tr>
<th>Region</th>
<th>Area (10^6 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>16</td>
</tr>
<tr>
<td>Argentina</td>
<td>86</td>
</tr>
<tr>
<td>Paraguay</td>
<td>22</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>11</td>
</tr>
<tr>
<td>India</td>
<td>24</td>
</tr>
<tr>
<td>Iran</td>
<td>27</td>
</tr>
<tr>
<td>Pakistan</td>
<td>10</td>
</tr>
<tr>
<td>China</td>
<td>37</td>
</tr>
<tr>
<td>(Former) USSR</td>
<td>171</td>
</tr>
<tr>
<td>Indonesia</td>
<td>13</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td><strong>357</strong></td>
</tr>
</tbody>
</table>

(SOURCE: http://www.abc.net.au)

Salt-affected Australian native trees and pastures

(Source: http://www.abc.net.au)

(Massoud, 1977)
## Effect of Salinity on Crop

<table>
<thead>
<tr>
<th>Soil Salinity Class</th>
<th>EC of the Saturation Extraction (dS/m)</th>
<th>Effect on Crop Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non saline</td>
<td>0 – 2</td>
<td>Salinity effects negligible</td>
</tr>
<tr>
<td>Slightly saline</td>
<td>2 – 4</td>
<td>Yields of sensitive crops may be restricted</td>
</tr>
<tr>
<td>Moderately saline</td>
<td>4 – 8</td>
<td>Yields of many crops are restricted</td>
</tr>
<tr>
<td>Strongly saline</td>
<td>8 – 16</td>
<td>Only tolerant crops yields satisfactory</td>
</tr>
<tr>
<td>Very strongly saline</td>
<td>&gt; 16</td>
<td>Only a few very tolerant crops yield satisfactory</td>
</tr>
</tbody>
</table>

(Source: FAO Natural Resources Management and Environment Department)
Waterlogging

Waterlogging usually results from overuse or poor management of irrigation water. Worldwide, about 10% of all irrigated land suffers from water logging. As a result, productivity has fallen about 20% in this area of cropland.

Waterlogging and salinization impacts can be further reduced by:

- Lining and covering of water conduits from the storage dams to the point of delivery
- More investment in education and management capacity rather than in drainage and soil improvement works.
Agricultural runoff

- Runoff of agricultural chemicals is primarily a localized problem where agricultural input use is high.
- Soil erosion and subsequent transport of sediments is caused by runoff of excess irrigation water from cropland.
- Soil erosion decreases the productivity of the land. Furrow irrigation causes more erosion than sprinklers or drip irrigation.
- Sediments transported by irrigation tail waters causing sedimentation of reservoirs and affecting the durability of sprinkler and drip irrigation systems, and creating significant problems to fish habitat and aquatic ecosystems.
Impact on groundwater

✓ Nitrates, salts, and other chemicals dissolved in the irrigation water will move beyond the reach of roots and eventually recharge groundwater

✓ Crops with high water and N requirements tend to increase the potential risk of nitrate pollution to groundwater

✓ According to various surveys in India and Africa, 20 to 50% of wells contain nitrate levels greater than 50 mg/l.
Public health impacts

✓ According to the World Health Organization, as many as 4 million children die every year as a result of diarrhea caused by water-borne infection.

✓ The most common diseases associated with contaminated irrigation waters are cholera, typhoid, ascariasis, amoebiasis, giardiasis, and enteroinvasive E. Coli.

✓ Crops that are most implicated with spread of these diseases are ground crops that are eaten raw such as cabbage, lettuce, strawberries, etc.

✓ Nitrogen levels in groundwater have grown in many parts of the world as a result of intensification of farming practice, particularly in irrigated lands.

✓ Nitrate levels have grown in some countries to the point where more than 10% of the population is exposed to nitrate levels in drinking water that are above the 10 mg/l guideline designed to prevent methaemoglobinaemia to which infants and elderly are particularly susceptible.
Policy Interventions

- Introduce water and power pricing that better represent the market value of water.
- Introduce transferable water entitlements.
- Set limits for allowable groundwater recharge (amount and quality) and introduce penalties for exceeding these limits.
- Provide incentives for land reclamation.
- Require exhaustive environmental impact assessment for new irrigation projects.
- Provide incentives for monitoring and reduction of the environmental impact of existing irrigation projects.
Engineering Interventions

✓ Incorporate environmental impact considerations in the design, Construction, and operation of new irrigation projects.
✓ Improve maintenance of irrigation infrastructure.
✓ Construct drainage facilities.
✓ Improve maintenance of existing drains.
✓ Reuse waste and drain water, and find alternative ways to dispose drainage effluent.
✓ Prevent or reduce canal seepage, i.e., through lining.

System Management Interventions

✓ Improve the operation of existing irrigation and drainage infrastructure through introduction of MIS
✓ Enhance farmers’ involvement in management and maintenance of irrigation and drainage facilities.
✓ Evaluate the feasibility of implementing on-demand water delivery to farms.
Irrigation/Agronomic Practices Interventions

✓ Minimize water losses in the on-farm distribution system, such that minimize deep percolation and surface runoff.

✓ Implement more efficient irrigation methods (Micro Irrigation instead of surface irrigation).

✓ Minimize sediment concentration in runoff water.

✓ Grow different crops or introduce different crop rotations

✓ Irrigate according to reliable crop water requirement estimates and leaching requirement calculations.

✓ Manage fertilizer programs so as to minimize nutrients available for detachment and transport.

✓ Apply soil amendments and reclamation practices.
Case studies

- In India, 2.19 million Ha have been reported to suffer from waterlogging in irrigation canal commands. Also, 3.47 million ha were reported to be seriously salt affected.
- In the Indus Plains in Pakistan, more than 2 million hectares of land is waterlogged.
- The soil of 13.6 million hectares within the Gross Command Area was surveyed, which revealed that 3.1 million hectares (23%) was saline.
- The Asian Development Bank (ADB) states that 38% of the irrigated area is now waterlogged and 14% of the surface is saline for use.
- In the Nile delta of Egypt, drainage is being installed in millions of hectares to combat the water-logging resulting from the introduction of massive perennial irrigation after completion of the High Dam at Assuan.
- In Mexico, 15% of the 3 million ha of irrigable land is salinized and 10% is waterlogged.
In Peru, 0.3 million ha of the 1.05 million ha of irrigable land suffers from degradation.

1/3rd of the irrigated land in the major irrigation countries is already badly affected by salinity or is expected to become so in the near future.

Present estimates for Israel are 13% of the irrigated land, Australia 20%, China 15%, Iraq 50%, Egypt 30%. Irrigation-induced salinity occurs in large and small irrigation systems alike.

FAO has estimated that about 52 million ha of irrigated land will need to have improved drainage systems installed, much of it subsurface drainage to control salinity.
Effect on Humans

Diseases

One negative effect is that the reservoirs can become breeding grounds for disease vectors. This holds true especially in tropical areas where mosquitoes (which are vectors for malaria) and snails (which are vectors for Schistosomiasis) can take advantage of this slow flowing water.

Resettlement

The record for the largest population relocated belongs to the Three Gorges dam built in China. Its reservoir submerged a large area of land, forcing over a million people to relocate.

"Dam related relocation affects society in three ways: an economic disaster, human trauma, and social catastrophe", 
## Rehabilitation & Resettlement

### Sardar Sarovar Vs Polavaram

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>Description</th>
<th>Polavaram Project</th>
<th>Sardar Sarovar Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basin</td>
<td>Lower godavari, G10</td>
<td>Narmada</td>
</tr>
<tr>
<td>2</td>
<td>River</td>
<td>Godavari</td>
<td>Narmada</td>
</tr>
<tr>
<td>3</td>
<td>Location</td>
<td>Near Polavaram Village, Andhra Pradesh 42Km U/S OF SACB. (81°-46'E,17°-36'N)</td>
<td>State : Gujarat Distinct : Narmada Taluka : Rajpipla (Nandod) Longitude : 73° 45' E Latitude : 21° 50' N</td>
</tr>
<tr>
<td>4</td>
<td>Catchment Area</td>
<td>3,06,643 Sq.Km</td>
<td>88,000 sq.km</td>
</tr>
<tr>
<td>5</td>
<td>States Involved</td>
<td>AP, Chattisgarh, Orissa</td>
<td>Madhya Pradesh, Gujarat, Rajasthan, Maharashtra</td>
</tr>
<tr>
<td>6</td>
<td>Gross Storage</td>
<td>194.60 TMC</td>
<td>335 TMC</td>
</tr>
<tr>
<td>7</td>
<td>Dead Storage</td>
<td>119.403 TMC</td>
<td>129 TMC</td>
</tr>
<tr>
<td>8</td>
<td>Live storage</td>
<td>75.20 TMC</td>
<td>206 TMC</td>
</tr>
<tr>
<td>9</td>
<td>Submergence at FRL</td>
<td>45.72M (+150'), A.P Area : 601.00 SqKm, odisha 648.05 Ha, Chattisgarh : 795.59 Ha</td>
<td>37533 Ha</td>
</tr>
<tr>
<td>10</td>
<td>Villages submerged</td>
<td>222</td>
<td>245</td>
</tr>
<tr>
<td>11</td>
<td>No of project affected families</td>
<td>44574</td>
<td>30144</td>
</tr>
<tr>
<td>12</td>
<td>No of population affected</td>
<td>188370</td>
<td></td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL IMPACT OF IRRIGATION**
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>13</td>
<td>RMC length &amp; Irrigation</td>
</tr>
<tr>
<td>14</td>
<td>LMC Length &amp; Irrigation</td>
</tr>
<tr>
<td>15</td>
<td>Command area</td>
</tr>
<tr>
<td>16</td>
<td>Design Discharge</td>
</tr>
<tr>
<td>17</td>
<td>Height of dam</td>
</tr>
<tr>
<td>18</td>
<td>length of dam</td>
</tr>
<tr>
<td>19</td>
<td>Type of Dam</td>
</tr>
<tr>
<td>20</td>
<td>Power Capacity</td>
</tr>
<tr>
<td>21</td>
<td>No of Units</td>
</tr>
<tr>
<td>22</td>
<td>Estimated cost of the project</td>
</tr>
<tr>
<td>23</td>
<td>Expenditure Incurred</td>
</tr>
<tr>
<td>24</td>
<td>Land Acquisition</td>
</tr>
<tr>
<td>25</td>
<td>% of land Acquired</td>
</tr>
<tr>
<td>26</td>
<td>No of villages for drinking water</td>
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<tr>
<td></td>
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Greenhouse Gases

- Reservoirs may contribute to changes in the Earth's climate. Warm climate reservoirs generate **methane**, a **greenhouse gas** when the reservoirs are stratified, in which the bottom layers are **anoxic** (i.e. they lack oxygen), leading to degradation of **biomass** through anaerobic processes.

- A theoretical study has indicated that globally hydroelectric reservoirs may emit 104 million metric tonnes of methane gas annually. Methane gas is a **significant contributor** to global climate change.
Environment Management Plans

1. Provisions to ensure that the quality of the supplied water does not contribute to salinity buildup on the irrigated land

2. Groundwater extraction rates be kept at or below recharge rates to prevent drawdown and related subsidence and habitat destruction

3. Implementation of sound irrigation and agronomic practices by farmers
Limit pesticide, herbicide, and petroleum-based fertilizer use, including using organic fertilizer, planting pest-resistant crops, and planting cycles.

Agricultural runoff must be managed to prevent impacts from excess nutrients, chemical pesticides and herbicides.

Reduce offsite sedimentation, nutrient pollution, and water quality degradation by planting vegetative windbreaks, practicing contour plowing, and maintaining soil moisture.
Final Remarks

✓ The potential to increase substantially the irrigated area of the world is limited.........But an increase of the irrigated area is inevitable...

✓ Use of existing supplies rather than harnessing of new supplies, to minimize their environmental impact is a requirement for long-term sustainability of irrigated agriculture (WU Efficiency)

✓ Prudent decision-making requires consideration of potential climate change scenarios on long-term decisions regarding water use and environmental impact
Time For Discussion