Presentation on

Implications of Hydropower for food security in a changing climate

Hydropower - Paving way forward for food security in a changing Climate through An assured success Mantra "7M" - An Innovative model for accelerated development

Global Water Partnership South Asia

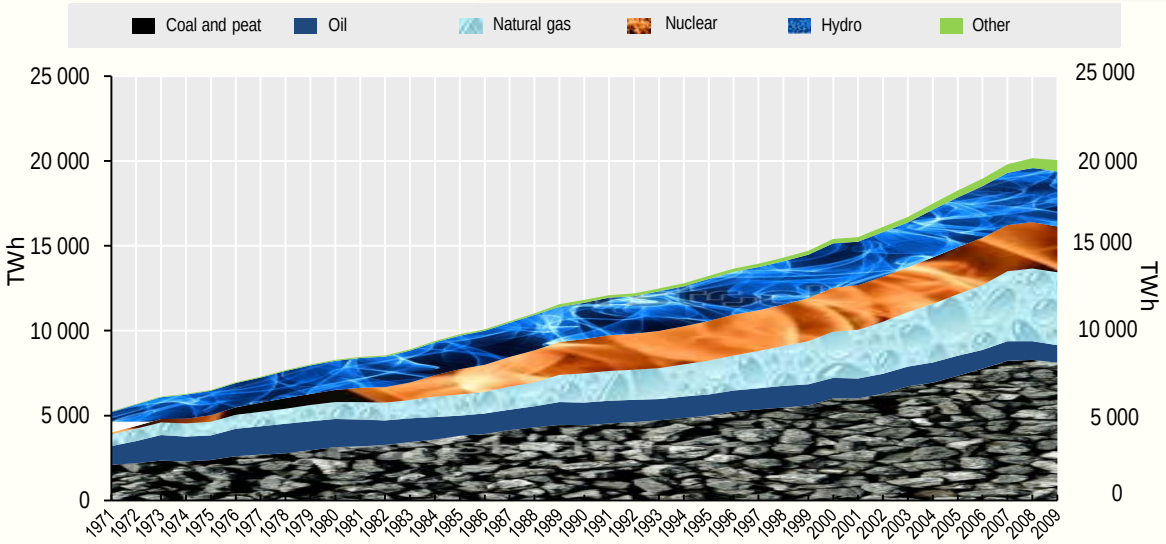
GWP

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम – जल संसाधन मंत्रालय)
(A Government of India Undertaking - Ministry of Water Resources)

Amit Gupta
Senior Project Manager
WAPCOS Ltd. (Secretariat, India Water Partnership – GWP, India)

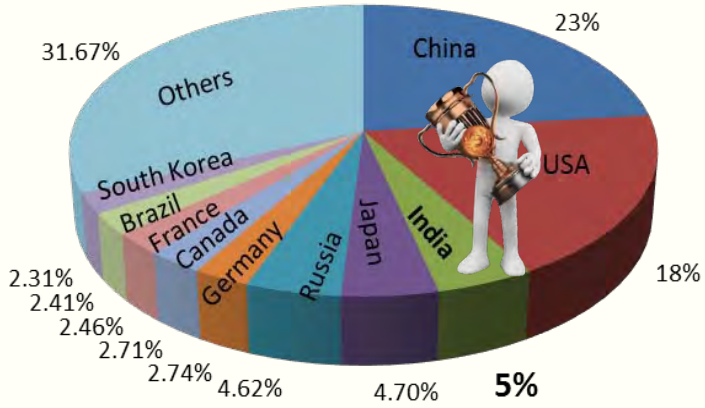
An Insight to Presentation

World Electricity Scenario



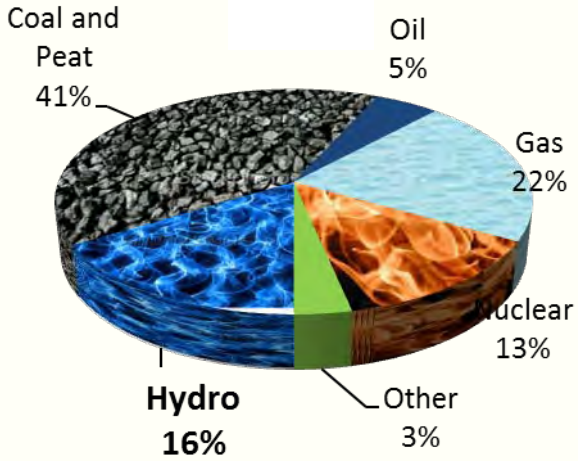
World - Electricity generation - Evolution

World Electricity Generation Country wise



Total 23,127 TWh

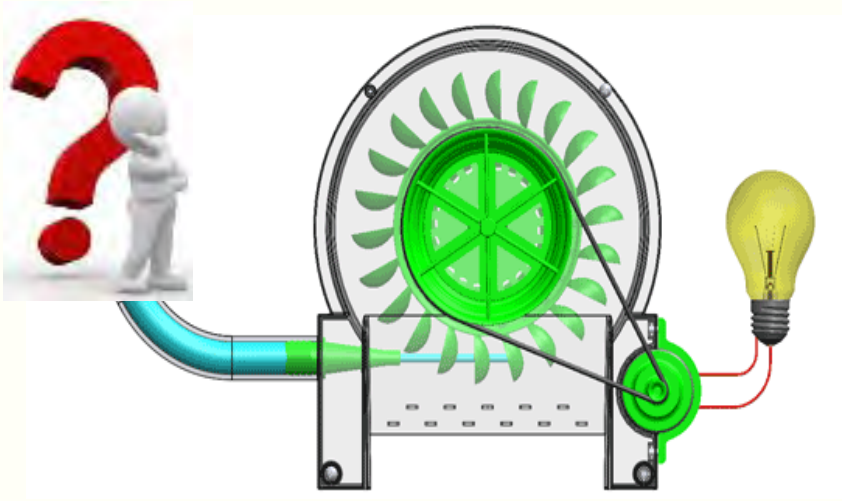
World electricity generation by source of energy



God's Justice - The **potential** is largest in areas where the energy needs are greatest, such as **Asia**, South America and Africa.

Top 10 largest power producing facilities

Rank	Station	Country	Capacity (MW)	Fuel type
1	**Three Gorges Dam**	**China**	**22,500**	**Hydroelectricity**
2	**Itaipu Dam**	**Brazil Paraguay**	**14,000**	**Hydroelectricity**
3	**Guri Dam**	**Venezuela**	**10,235**	**Hydroelectricity**
4	Kashiwazaki-Kariwa Nuclear Power Plant	Japan	8,212	Nuclear
5	**Tucurui Dam**	**Brazil**	**8,125**	**Hydroelectricity**
6	**Grand Coulee Dam**	**United States**	**6,809**	**Hydroelectricity**
7	Bruce Nuclear Generating Station	Canada	6,738	Nuclear
8	**Longtan Dam**	**China**	**6,426**	**Hydroelectricity**
9	Uljin Nuclear Power Plant	South Korea	6,157	Nuclear
10	Yeonggwang Nuclear Power Station	South Korea	6,139	Nuclear

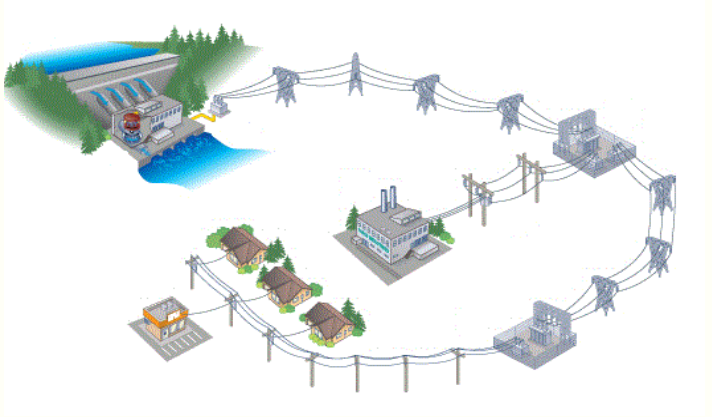


Hydropower scheme – Lighting Millions of Lives

Hydropower- A Bouquet of Benefits

- ✓ **Totally renewable & non-polluting**
- ✓ Provide a **more stable price** regime over a long period of time.
- ✓ It has remarkably **higher efficiency** (over 90%) **compared to thermal** (35%) and gas (around 50%).

- ✓ Ideally suited for meeting the **peaking demand**; thus, useful for **enhancing reliability & stability** of the power supply system.
- ✓ **Long life** – The first hydro project of India completed in 1897 is still in operation at Darjeeling.



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- **Flood Control:** Dams help **prevent the loss of life** & **property** caused by flooding, **protecting from the environmental hazard** and long term effects on climate change
- **Water Storage:** Dams create reservoirs that **supply clean & safe water** for many uses, including industrial, municipal, and agricultural, **promoting health and hygiene** and maintaining the clean environment.
- **Irrigation:** Larger percent of cropland is irrigated using water stored in reservoirs & dams. Thousands of jobs are tied to producing crops grown with irrigated water.

- **Debris Control:** In some instances, dams provide enhanced environmental protection, such as the retention of hazardous materials and detrimental sedimentation.

PISCICULTURE NAVIGATION,
RECREATION, TOURISM

SOCIO-ECONOMIC
DEVELOPMENT OF AREA

IRRIGATION, WATER SUPPLY
FLOOD CONTROL

LOW GENERATION
COST

LONG LIFE &
HIGHER EFFICIENCY

ANSWER TO
CLIMATE CHANGE
& FOOD
SECURITY

RESPONSE TO
PEAKING DEMAND

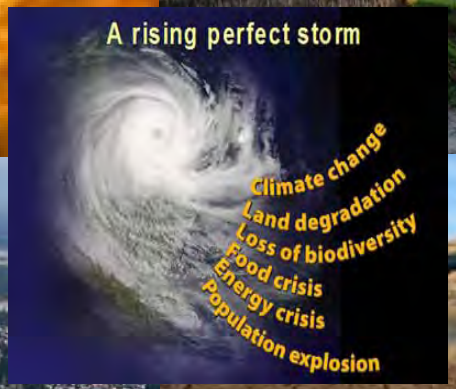
RENEWABLE & NON
POLLUTING

BOUQUET OF BENEFITS

Hydropower – A solvable dilemma

Climate Change – *A Nightmare*

Churning life upside down



MELTING GLACIERS

FAMINE

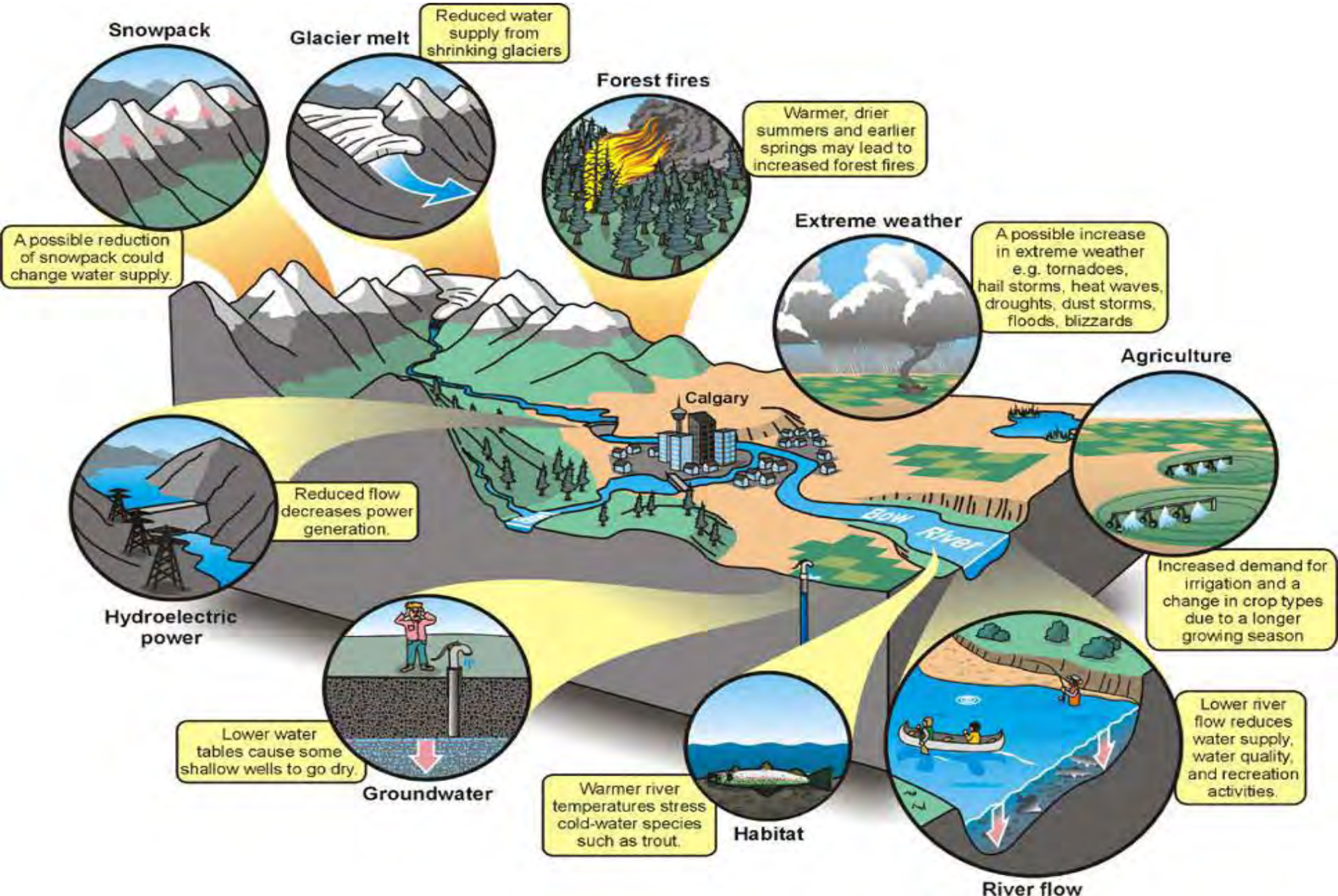
Moving towards a point of no return

- World's poor : Front line
- Ecological catastrophe brought about by climate change will be unavoidable
- Potential to undermine human development across many countries

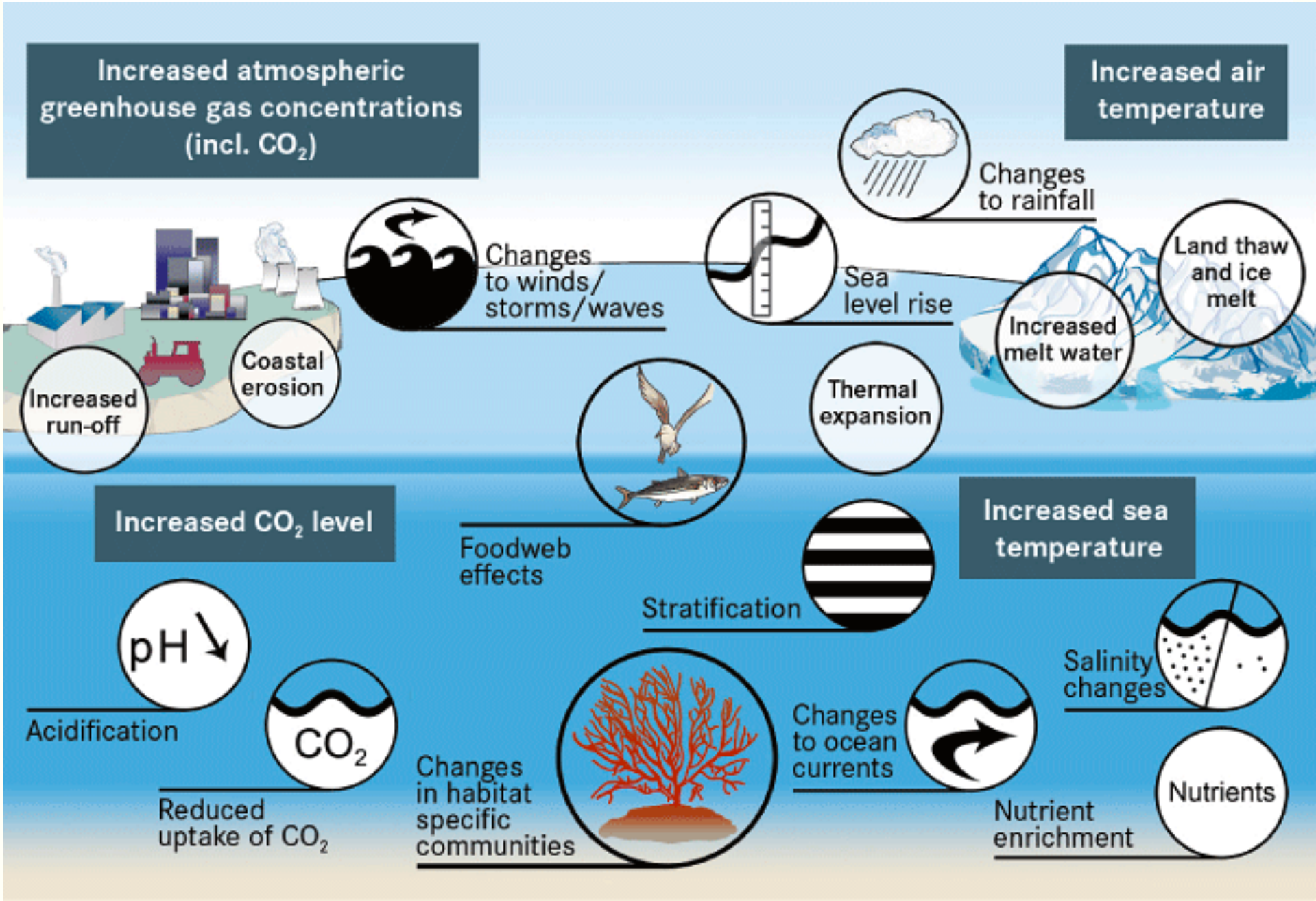
- Even lead to a reversal of current developmental progress

- India's challenge : Sustaining rapid economic growth amidst the increasing global threat of climate change.
- More than 56% of workers: Agriculture and allied sectors
- while many others earn their living in coastal areas through tourism or fishing

Impacts of Climate change



Manifestation of Climate change on Ecosystem



Hydropower- Ray of Hope as a step towards Food security in Changing Climate

- **Banks** of **water & energy security**
- Help achieve **climate change mitigation** goals
- Generating **clean, green, renewable, sustainable** & **affordable** energy,
- **low carbon emissions** and therefore, **environmentally friendly**, to a larger extent.

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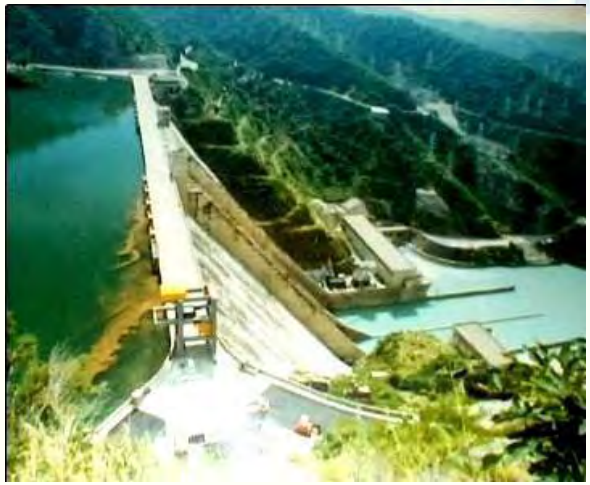
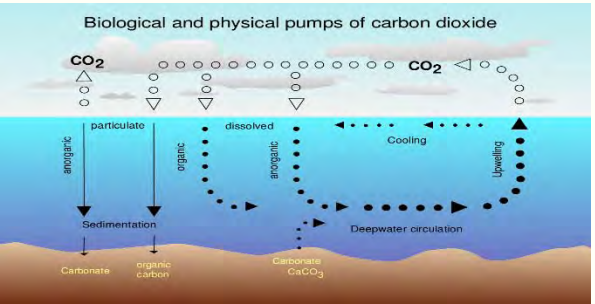
- Mitigating extreme weather events, with storages,
- Balancing water flows during floods & droughts.
- Aid in unwinding wrath of climate change
- Ensuring food security through regulated irrigation releases, on priority.




Hydropower - An Effective tool to combat wrath of Climate Change





- ✓ **Environmentally friendly, clean and renewable energy** source

- ✓ Dams helps in reducing the **wrath of climate changes** : **water flow** regulators **during the extremities of climate**, ensuring the availability of water for irrigation during dry seasons.

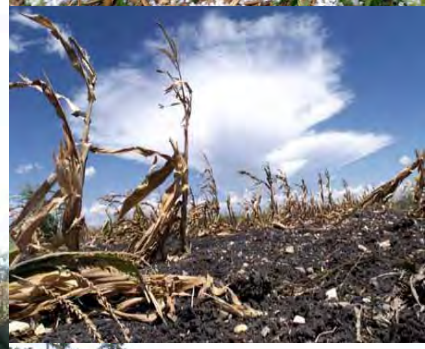
- ✓ **Reservoirs** at times works as the **carbon sink** by **absorbing the carbon dioxide gases** from the atmosphere

Food Security – Diminishing with adversities of Climate Change










Food Security

Food Security

- **Food security: All people at all times have physical, social & economic access to sufficient, safe & nutritious food to meet their dietary needs**

Dimensions of Food Security

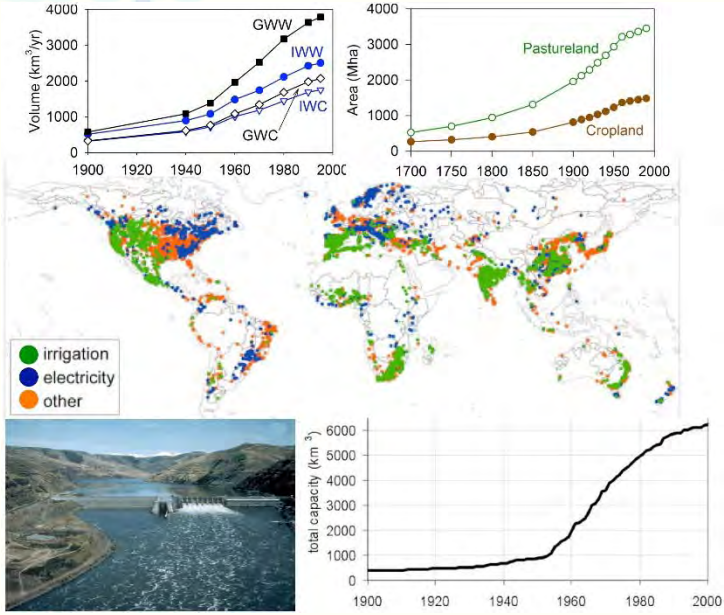
Food Security: In totality

- **Availability**: **Adequate food** is ready at people's disposal
- **Access**: Adequate **resources to obtain the food**
- **Utilization**: Human body function to **adequately ingest, digest and metabolize** the food.
- **Stability**: Assurance of continuation of fore-mentioned dimensions.

Hydropower - Boon to boost Food Security in changing Climate

- ✓ By **2025**, 80% of additional food production, from irrigated land.

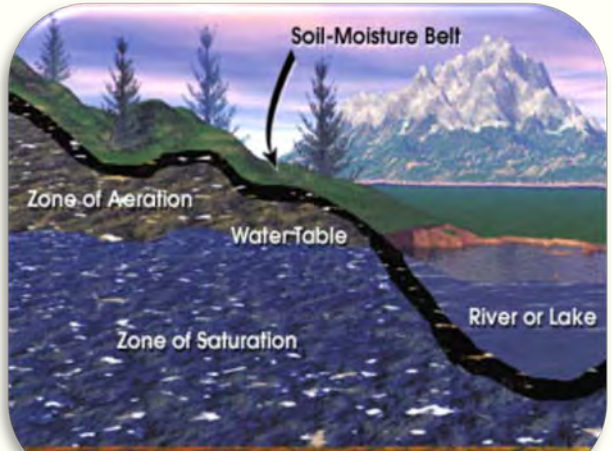
- ✓ The International Commission on Large Dams (ICOLD): **Most dams** worldwide have been built for **irrigation purposes**, followed by hydropower generation, water supply and flood control.



- ✓ 30-40% of irrigated lands worldwide, which contribute 12-16% of global food production, **rely on dams**


IMPROVEMENT IN FOLLOWING PARAMETERS
THROUGH HYDRO POWER
· Transport
· Equitable Distribution
· Marketing
· Affordability
· Purchasing Power
·Production
· Processing
·Water & Soil management
· Trade & Srockpiling
· Good Health Indicators
· Nutritious Food
· Food Saftey & Quality
· Clean Water
· Sanitation
AVAILABILITY
ACCESS
UTILIZATION
STABILITY
FOOD SECURITY

Strengthening the Pillars of Food Security



Food Availability:

- ✓ **Agriculture based economy** is water dependent, **water security** plays a **vital role** to ensure abundant availability of food.
- ✓ As **a bank of water security**, aid in **soil management**.
- ✓ Hold back water and **raise the shallow groundwater tables**.

Food Access:

- ✓ **Socio-economic development** of the entire region where it is executed
- ✓ Development of the **allied infrastructural facilities** such as transit facilities, basic health care facilities, and institutional buildings etc.,
- ✓ Projects: **Employment avenues** for local people & outside as well
- ✓ Promoting **Economic growth of the region**, strengthening the purchasing power of the people
- ✓ **Economic** as well as the **physical access** to the food security







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Food Utilization :

- ✓ **Multipurpose dams** : Serving the nearby communities with **water supply**.
- ✓ Providing the **clean & safe water** for **drinking** as well as **preparation of food**.
- ✓ Creating a **healthy environment** for the population.
- ✓ Allied services developed serve the community with the social development, **hygiene & clean environment** of the region.

Food Stability:

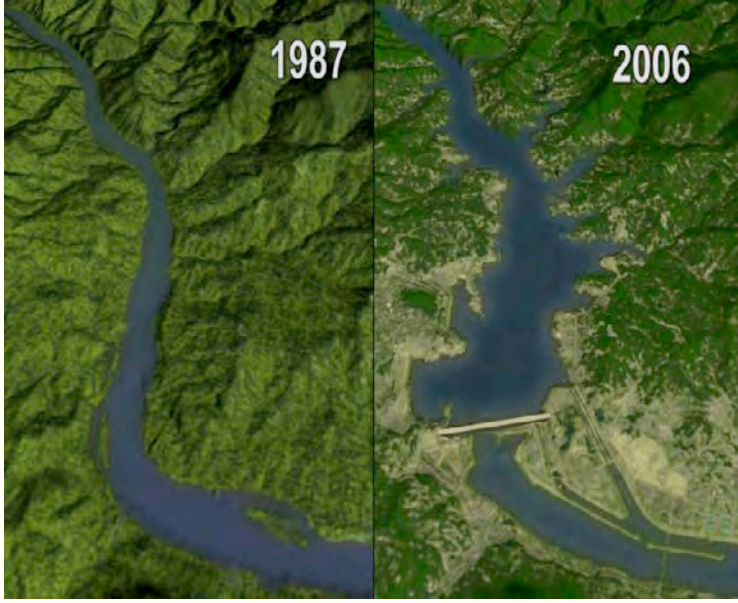
- ✓ Food **availability**: *Water Security*
- ✓ Food **Access**: *Socio-Economic development of the region*
- ✓ Food **Utilization**: *Clean & Hygienic environment*
- ✓ Dams: Ensure **stability** of all the three factors **over the time**.

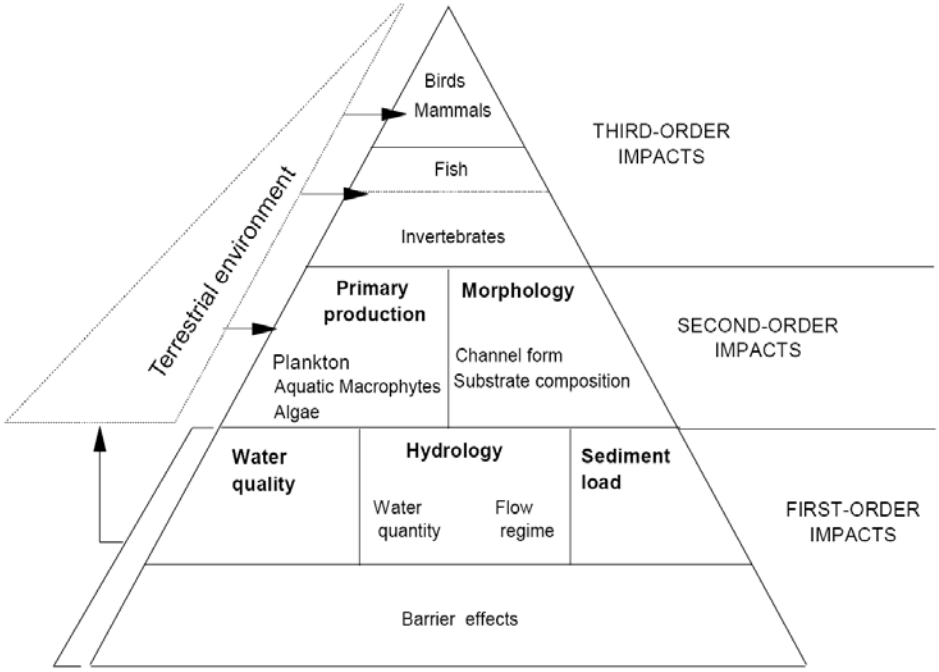
Hydropower – Looking Flip side of the coin & associated perceptions with challenges

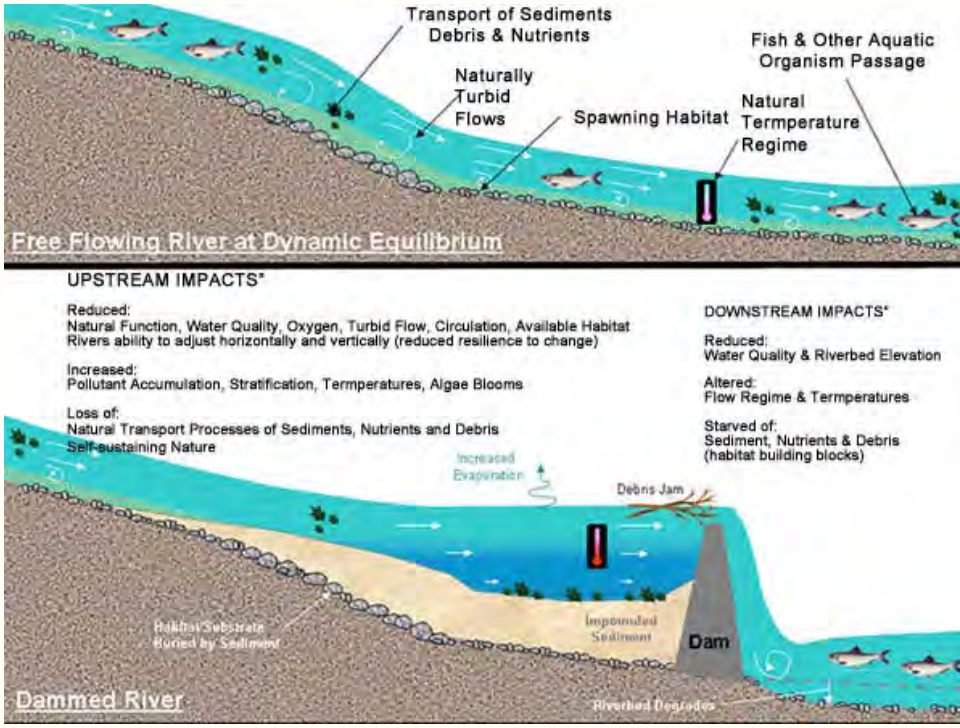
- Dams **significantly impact** on freshwater ecosystems
- **Conflicting demands** of water requirement for agriculture

- Construction of dams & the creation of reservoirs: **Rehabilitation & Resettlement** of a high number of people
- **Large dam** projects : **Widespread criticism** due to their **social and environmental impacts**

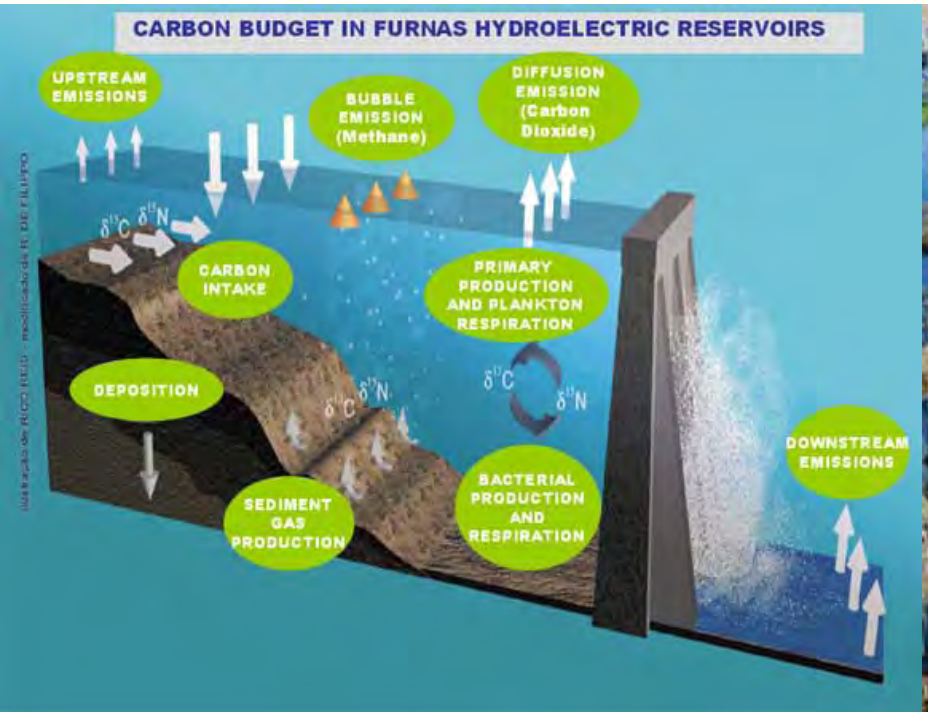
- The dams and reservoir projects often resulted in first, second and third-order environmental impacts.
- Effects on the aquatic and terrestrial ecosystems and biodiversity
- Impacts on fisheries upstream and downstream of the project due to blockages of the migration pathway
- Impact on the natural flood regime





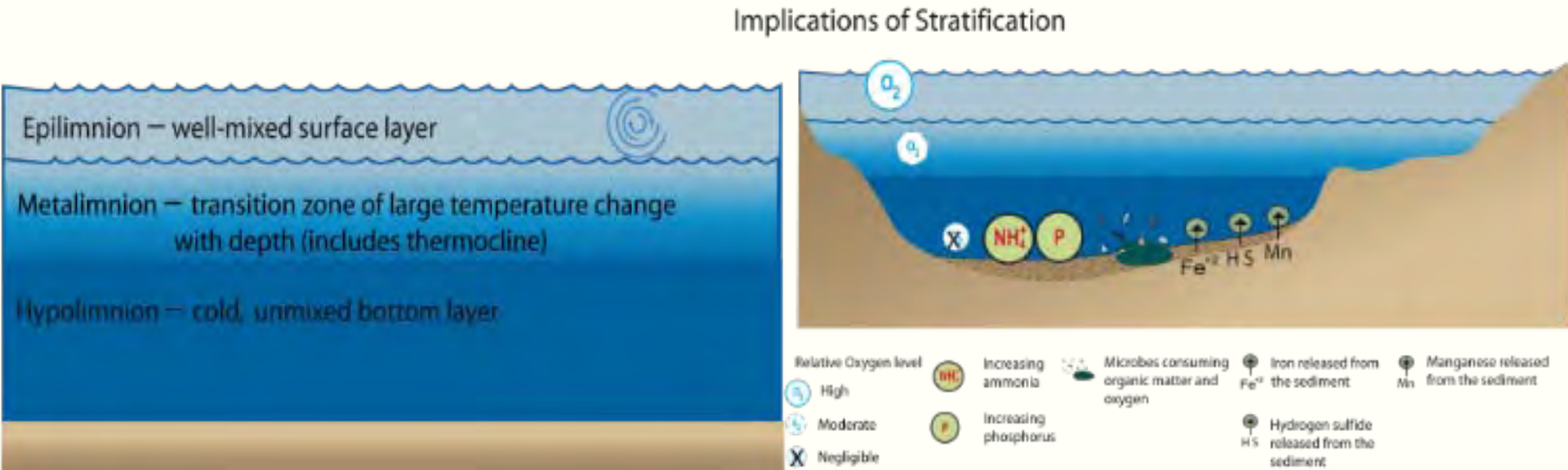


- **Emission of greenhouse gases from the reservoirs**
- **cumulative impacts as a result of cascade-projects**
- **Impact on land use change i.e. floral & faunal diversity due to reservoir submergence area, in the catchment area and in the to-be resettled area**
- **Inter-basin transfers, fluctuations in the downstream flow between the peak and the off-peak period for peaking hydropower plant, were also found to have an adverse downstream environmental impact**



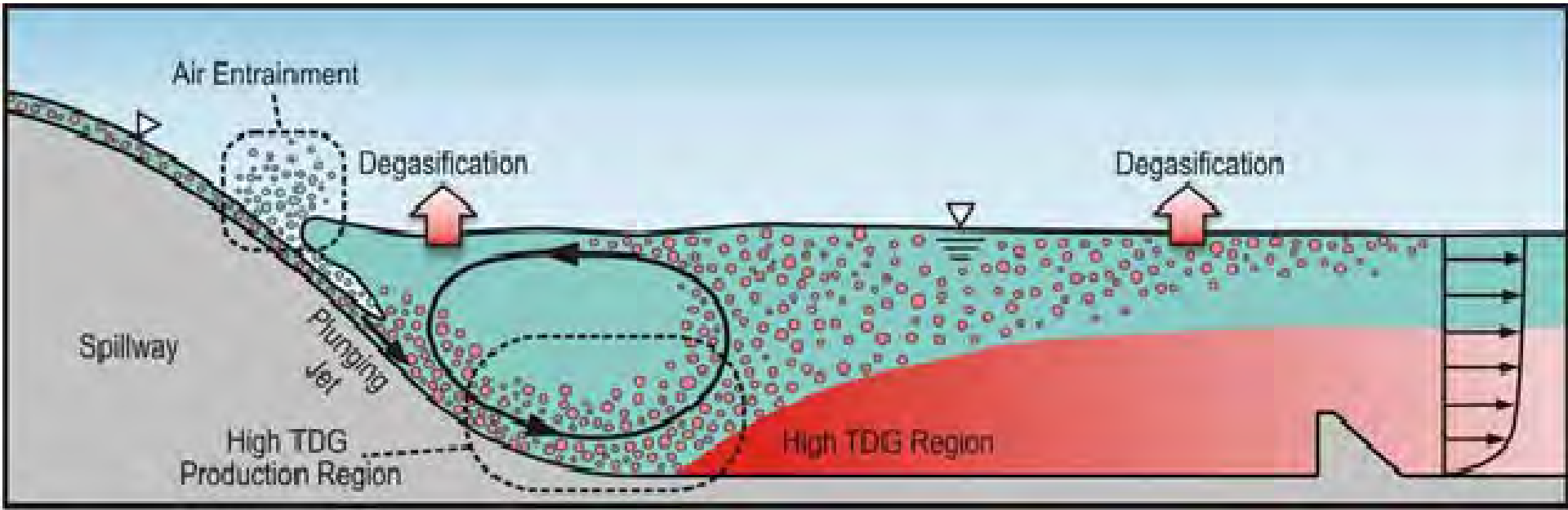
Reservoirs and Stratification

- Storage projects : Reservoirs formed
- Reservoirs : Significantly slow the rate of flowing water to downstream
- Surface temperature increases, warmer water moves upwards
- Colder water sinks toward the bottom because of its higher density
- The bottom layer is the coldest and the top layer the warmest
- Colder water : reduced oxygen levels
- water is released from the colder, oxygen-depleted depths, downstream habitat conditions change because of the reduced oxygen level in the water.



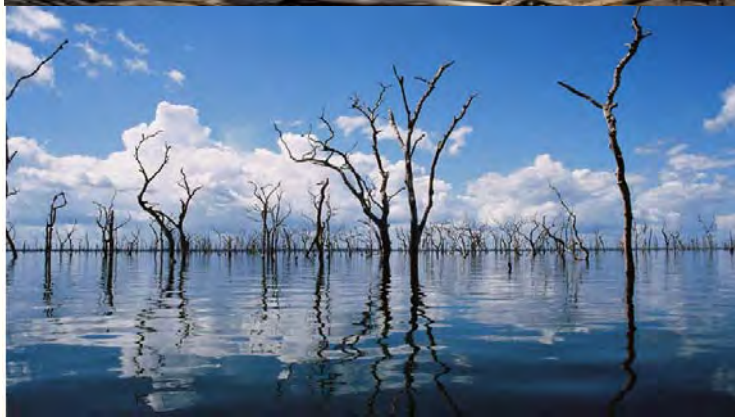
Supersaturation

- Air trapped in water spilled over a dam as it hits the pool below, creating turbulence
- Level of nitrogen dissolved in the water increase
- Affected water does not lose the excess nitrogen quickly
- Fish and other species, supersaturated water can enter tissues. If fish swim from an area supersaturated with nitrogen to a lower pressure area, a condition similar to "the bends" in scuba diving can occur. This effect causes injury and can even cause death to fish



Changing Water Levels

- Storage project: Inundation
- Habitat conditions change and a new equilibrium emerges.
- Impacting species that traditionally grow, nest, feed, or spawn in these areas.
- Water level vary based on the "power peaking"
- Riparian zone: Ineffectively established shoreline vegetation

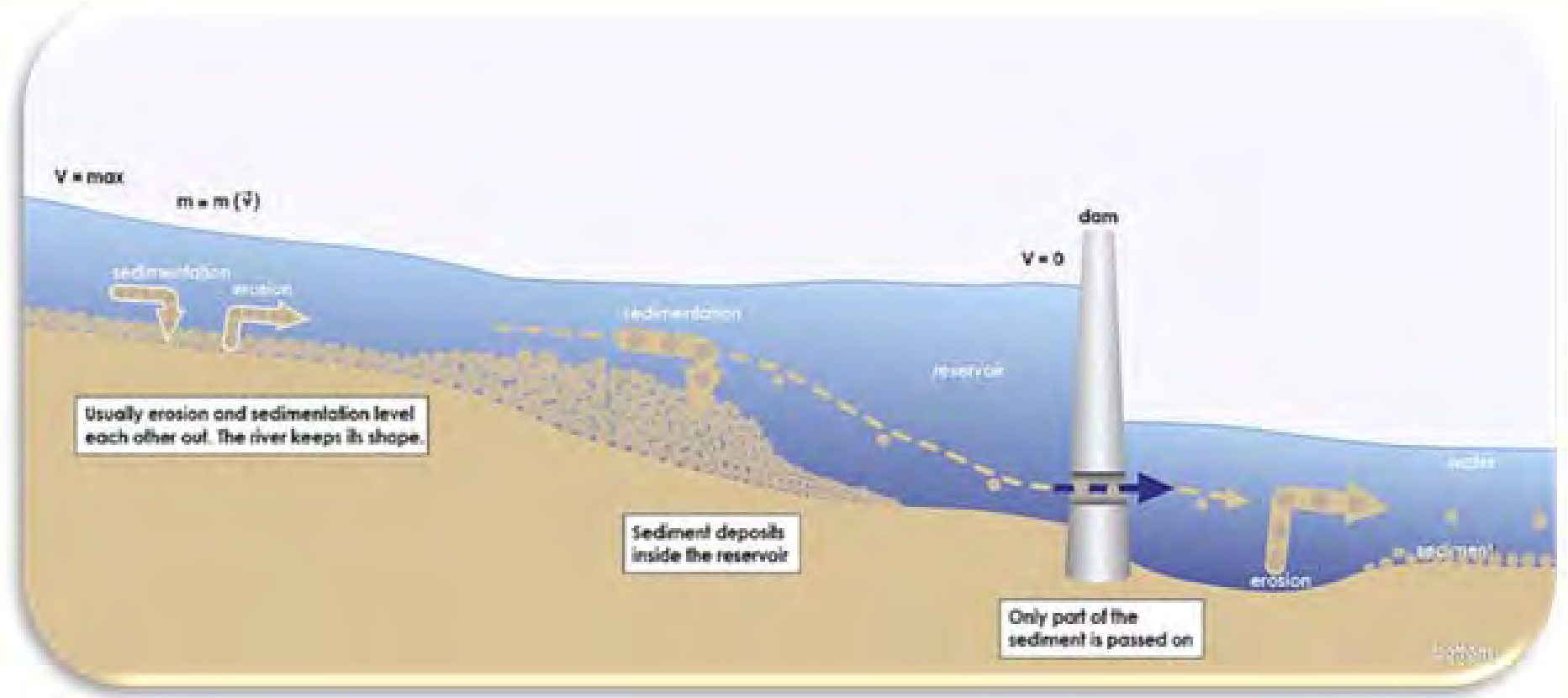


Erosion

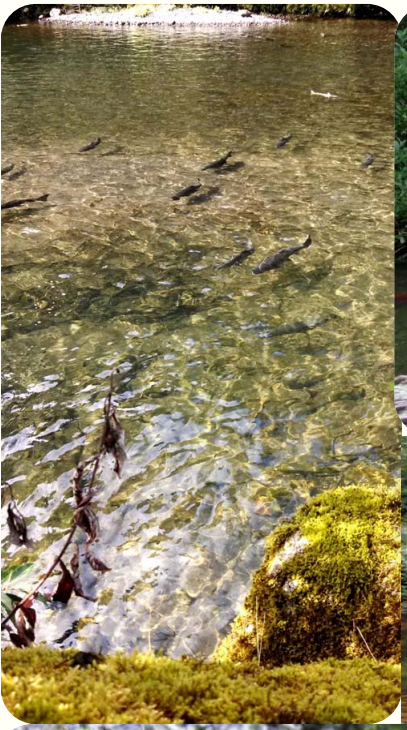
- Changing water levels and a lack of streamside vegetation can also lead to increased erosion
- Cutting deeply into its banks
- Result in further changes to a riparian zone and the species which it can support

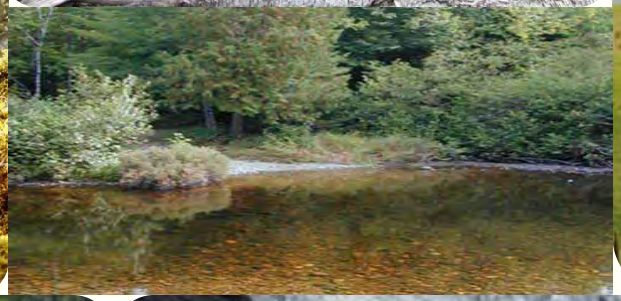
Sedimentation

- **Dam** is a physical barrier, **blocking sediments**
- **Sediments build-up** depends on **Ability of a river to "flush"** the sediments past the dam
- **Downstream habitat** : Decline due to **deprived organic and inorganic nutrients**
- **"Nutrient Loading"** : Reduced oxygen level at bottom
- **Gravel trapped:** Affects **Spawning areas** for fish on downstream



Changing Habitat Conditions for Fish and Wildlife

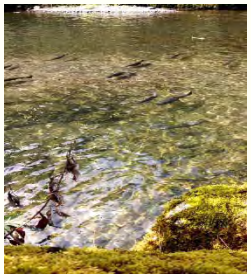


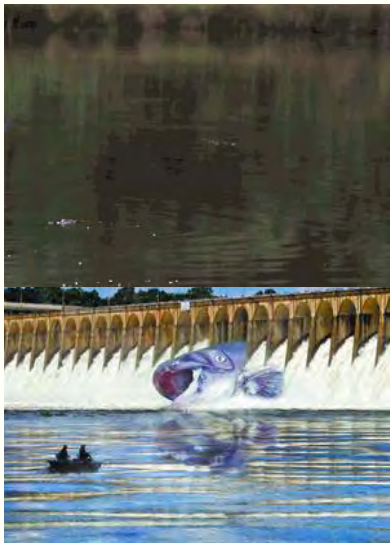


Fish

- Dam : Physical barrier for migration of adult fish
- Reservoirs :Changes in downstream habitat conditions
- Declination of Important food plant source of some of species
- Slower moving waters : Disoriented fishes and length of time it takes smolts to reach the ocean may increase

- Increased exposure to predators
- Fish passing through or around a dam can become stressed, injured, disoriented, or die because of contact with turbines, the walls of the dam, or deflection screens
- Supersaturation
- Significant Energy lost during migration through barrier



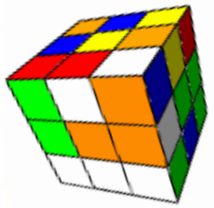


Wild Life

- Riparian vegetation : critical habitat for birds, waterfowl, and small and large mammals
- Inundation of a free-flowing river, the nesting, forage, and cover provided by these areas is temporarily or permanently lost
- Habitat is lost, animals are forced to move to higher ground, predators are more abundant, or the territory is already occupied
- Water levels stabilize at a new height, vegetation in riparian zones can re-emerge and species can re-populate an area

Hydropower - Solution to Challenges at Flip Side - the Way out

- **Problems & solutions go hand in hand**
- **Perceived success or failure is often dependent on a number of non-hydroelectric project activities**
- **Measures are part of a much larger and complex whole**
- **Environmental & Social impacts: Subjected to widespread criticism are inevitable, can be addressed by Protection, Mitigation and Enhancement strategies, to a reasonable extent**



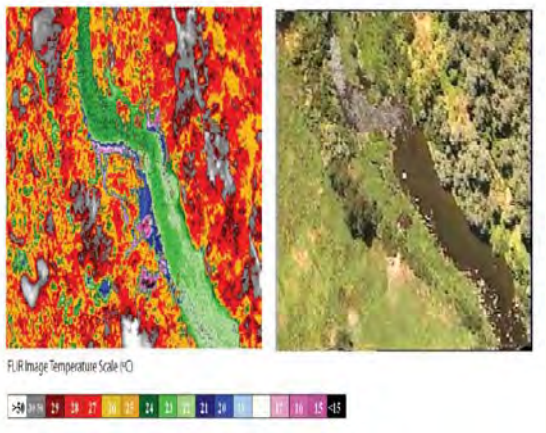
Solutions to Socio-Economic issues:

- **Negative social and ecological impacts - to be mitigated or compensated for which, the participation of all relevant stakeholders, including the affected communities, at an early stage is an important prerequisite**

- **Participatory approach: Resolves Rehabilitation & Resettlements issues to a larger degree, and brings prosperity & growth to the region as a whole**

Solution to Conflicting water demands for both hydropower and agriculture in the same basin

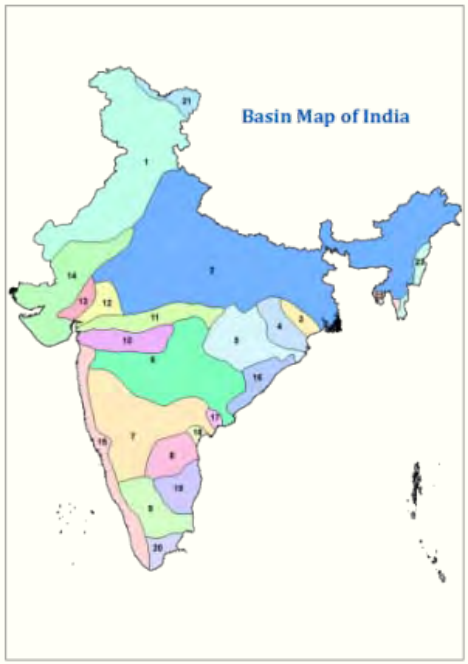
- Improved monitoring of upstream flows and rainfall

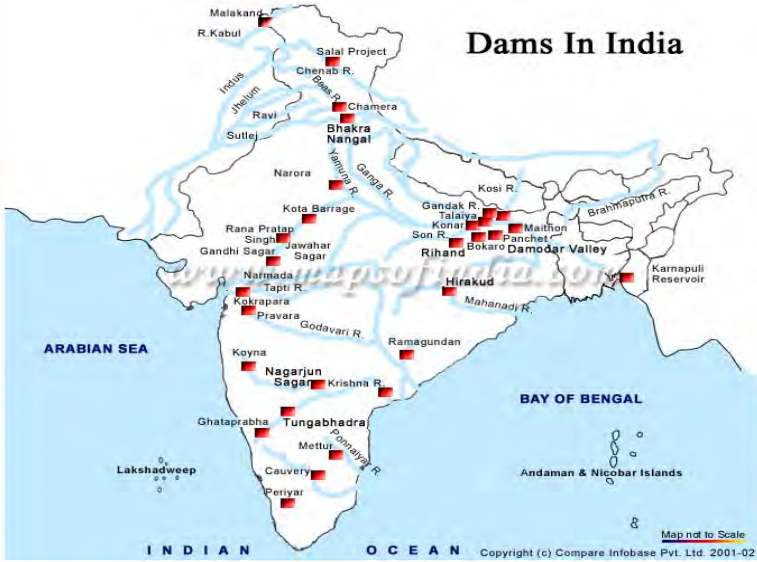


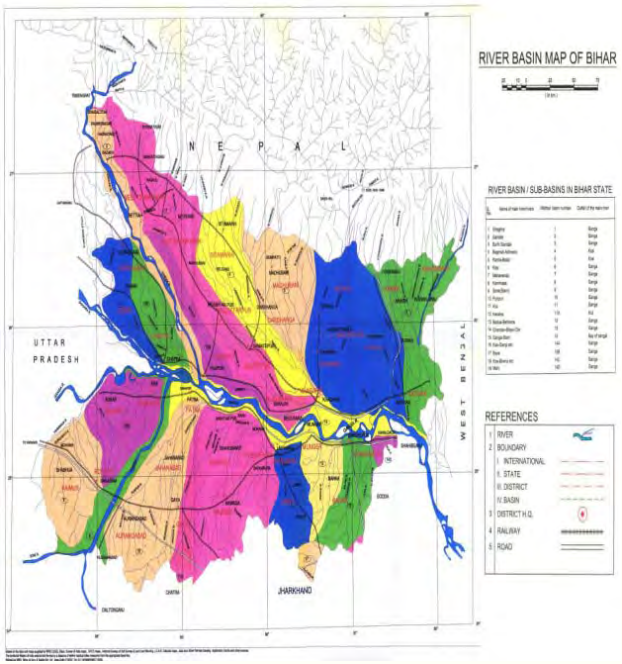
- Using both terrestrial instrumentation and satellite remote sensing to improve the benefits derived from both hydropower and agriculture.

Solutions to Ecological & Climatic issues

- **In addition to technical solutions, information exchange & coordination between different institutions and sectors remains a key component for multi-purpose dams.**







Basin-wide coordinated approaches for all dams on a river system: important way to sustain ecosystems and the overall benefits generated by dams.

Protection, Mitigation & Enhancement Strategies

- **Protection strategies focus on preserving areas in a watershed that are ecologically important, healthy and intact. Ex: Wetland**

- **Mitigation Strategies: In situations where habitat conditions are seriously degraded and impacts are unavoidable and cannot be recovered, strategies may be employed to help offset these losses. Ex: Building Hatchery**

- **When a change to the environment occurs, one means of addressing the new effects is to establish enhancements that minimize or alleviate these effects. Ex : Vegetation of Riparian zone.**

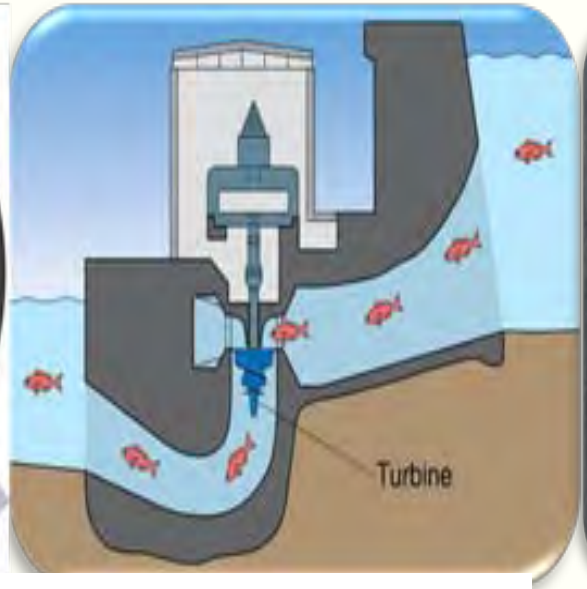
- **Enhancement: Innovations in modification of physical structures and operational changes.**

(A) Modifications in Physical structures

Modifications to a hydropower project's physical structure to effectively address many issues.

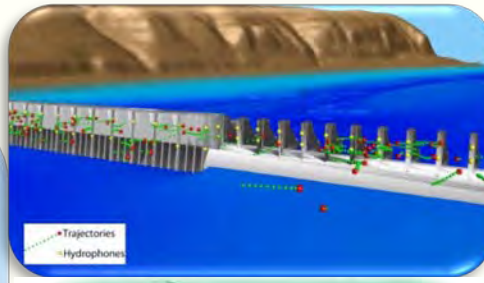
Strategy: ***Surface Collectors, Fish Screens, Turbine Modifications and Guidance Devices***

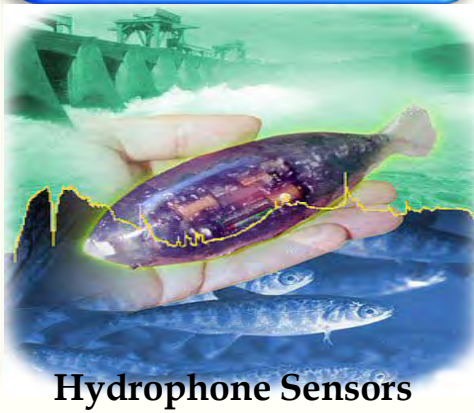
Issues: **Fish Migration, Fish Populations and Maximizing Generation**



Fish Friendly Turbines

Fish Screens





Hydrophone Sensors guiding Fishes to passages

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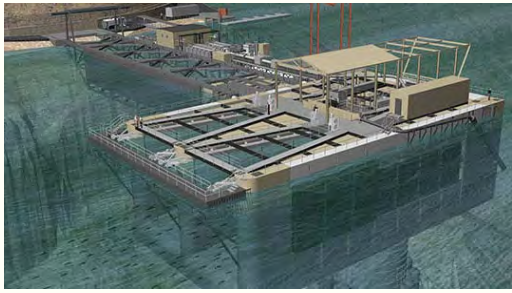


Strategy: Fish Ladders and Upstream Fish Passage

Issues: Fish Migration and Fish Populations

Fish ladders are the most common structural modification designed to assist journey of fish upstream of the Dam

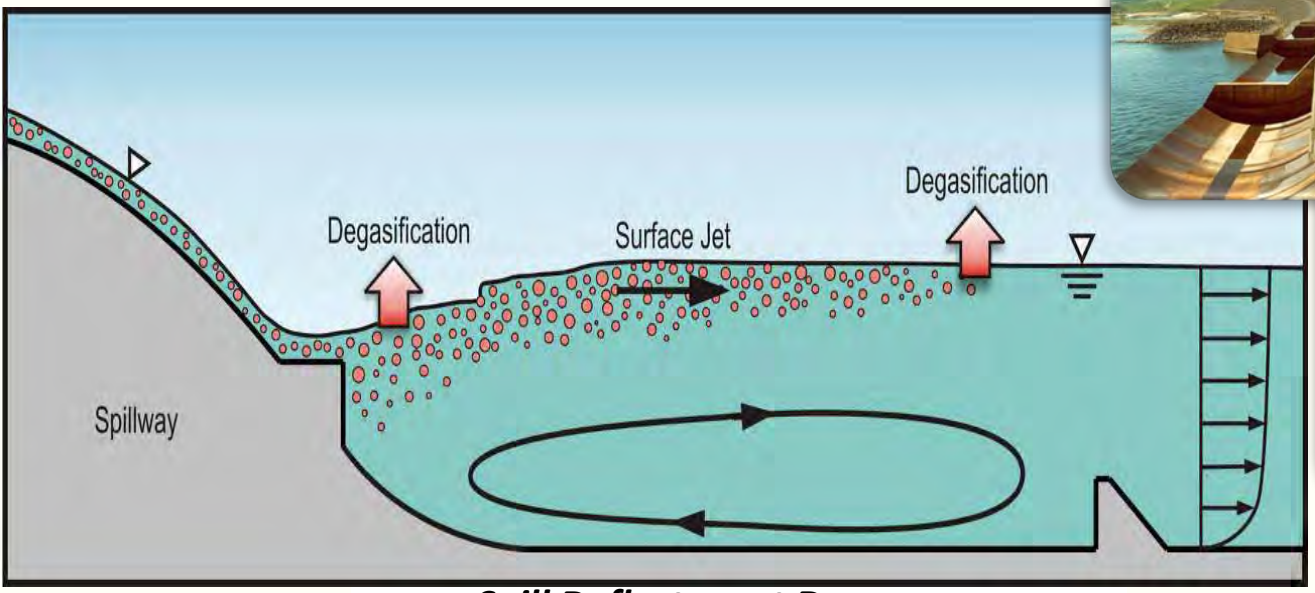
Fish ladder in Dams & Movement of Fishes in Fish Ladder

Contd…

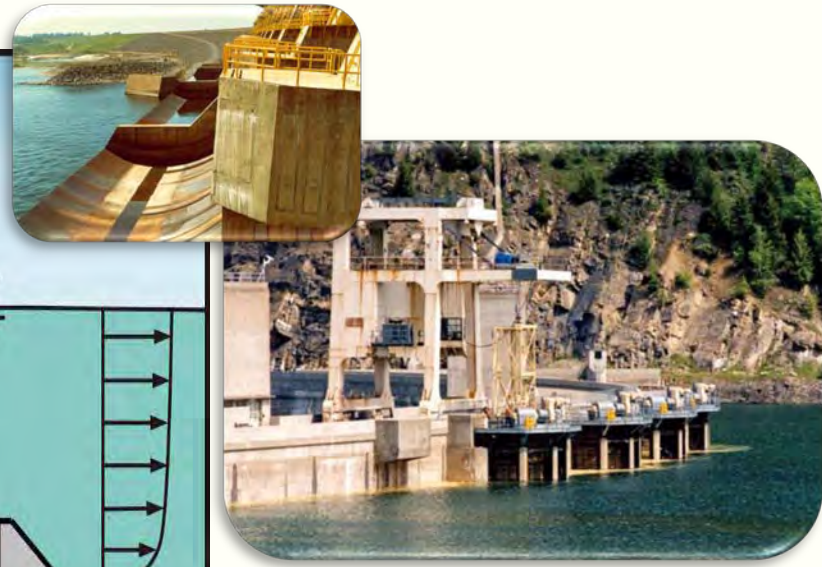
Strategy: **Spill Deflectors and Selective Water Withdrawal**

Issues: **Supersaturation, Water Temperature and Oxygen Levels**

- **Spill deflectors** (also called flip lips) : Reduce nitrogen supersaturation caused by water plunging into a pool several to a few hundred feet below a spillway.
- **Gates built at different depths** of water, allowing water to pass through these gates, adjustments (often called selective withdrawal) can be made to regulate changes in water temperature and oxygen levels.



Spill Deflectors at Dams



Selective withdrawal gates at Hungry horse Dam, Montana

Contd…

Strategy: Boat Ramps and Other Shoreline Recreational Access

Issue: Reservoir or River Access

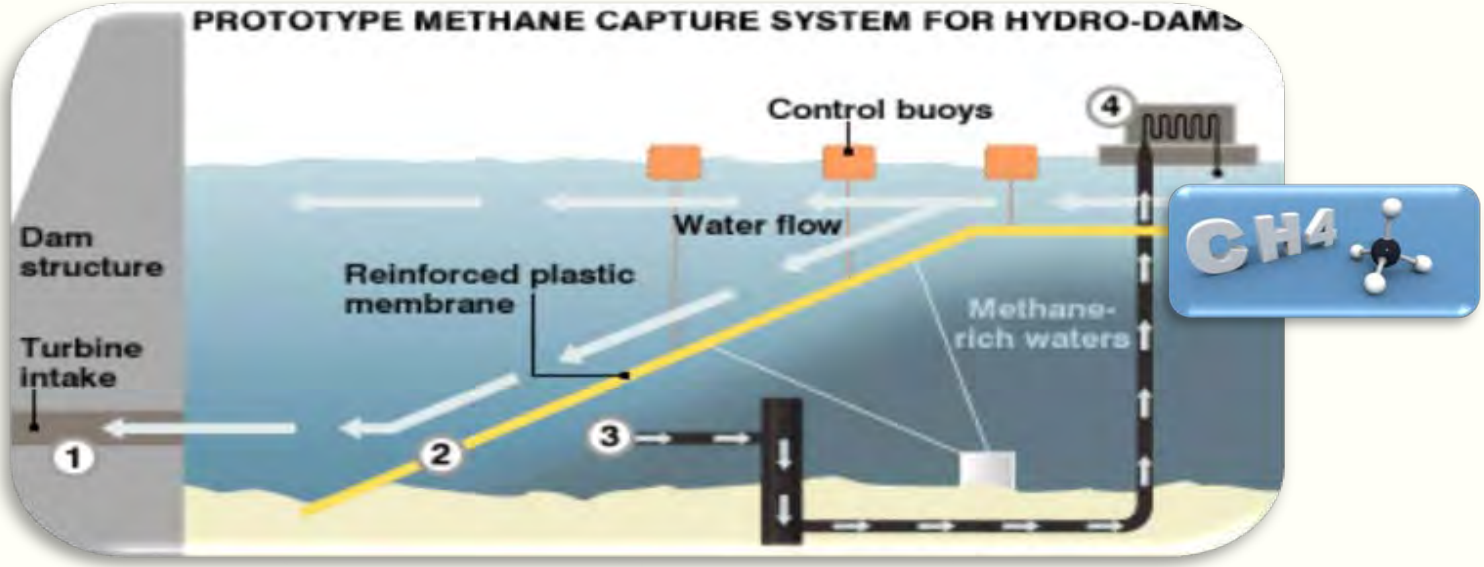
- The building of **boat ramps, camp grounds, picnic areas** and similar improvements to support the social interests of a community.
- Built up and downstream of a project : **Ensure a river reach is as accessible** and friendly to people as possible.
- Such improvements can also be aesthetic in nature and **help the local economy** by supporting tourism.

Contd…

Strategy: Extraction of Methane Gas from the Dams

Issue: Emission of Green House Gases from Reservoirs

- Installation of the deep suction pumps : to draw the methane rich water to the surface for separation of gas captured in the water.
- The methane gas will be separated & same will be stored in a sealed vessel.
- Depleted water returns to the reservoir.
- Extracted Methane Gas is used as energy source for running steam engine for generation of electricity.



Methane capture system for Hydropower Dams

(B) Operational Changes:

Operational changes refer to how projects can regulate either

- the rate of water flow in a river, or
- how water passes through a project

Run-of-river projects : Limited or no ability to regulate the rate of water flow in a river

Projects with reservoirs: most common operational changes involve "flow augmentation" or "permanent drawdowns."

Strategy: Flow Augmentation

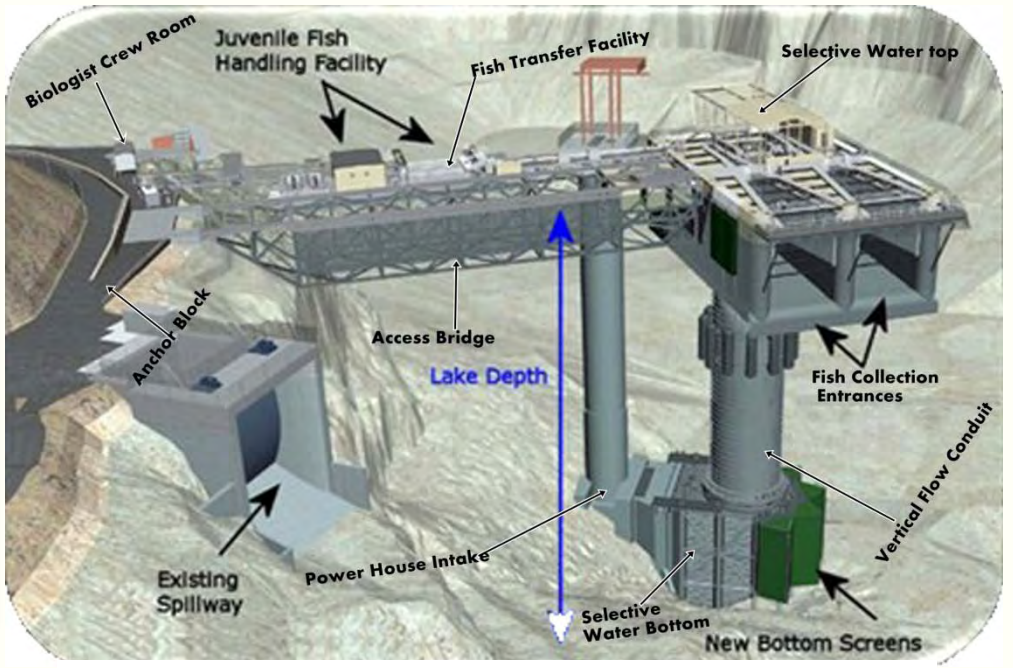
Issues: Fish Migration, Fish Populations, White Water Boating

- To reduce the in-river time of juvenile journey, a "**water budget**" can be prepared to release water from the upstream storage reservoirs.
- When this occurs, **water** not passing through a turbine area is released **over a dam's spillway**.
- **Water** is stored and then **released** in **concert with juveniles migrating downstream** in a particular season, ensuring Freshet condition.

Strategy: Permanent Drawdowns

Issues: Water Temperature, Stratification, Oxygen Levels, Fish Migration, Fish Populations and White Water Boating

- Permanent drawdowns :lowering the water level of project's reservoir largely or completely restores a river to its "natural" state
- Project loses all or most of its ability to store water and thus regulate the generation of electricity to times when it is most needed and valuable



Fish Migration & Selective withdrawal gates

Strategy: ***Barging and Other Transportation Devices***
Issue: ***Fish Migration and Fish Populations***

- **Transportation uses the bypass system** to move **fish into barges**.
- Release the juvenile fishes back into the water several miles **downstream, less risky**
- **"Trap and Haul"** : Fish collection facilities and trucks are used to pass returning adults from one area of the river to another.

Hydropower – The Game Changer

- **Multi-purpose dam projects: Regional development programmes, improve food production, electricity supply**, and the general physical and socio-economic infrastructure in rural areas.

- **Environmental and social impacts**: inevitable, **can be mitigated**

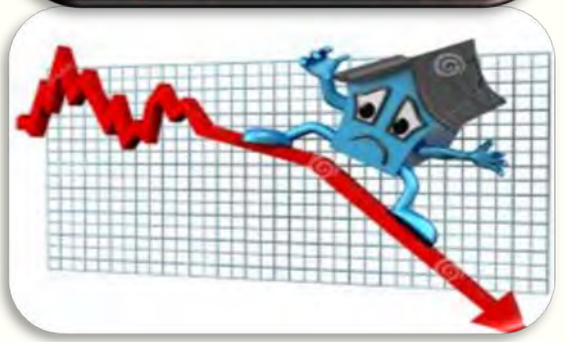
- **Conflict of interest**: Resolved by **careful consideration & coordination** amongst the ***different users and judicious trade-offs*** between effectiveness and productivity.

- **Providing clean and reliable energy**, storage volume to improve **drinking water supply or agricultural food production**, and **enhanced flood control**, they contribute to **energy, water and food security** - and to **human security in general**

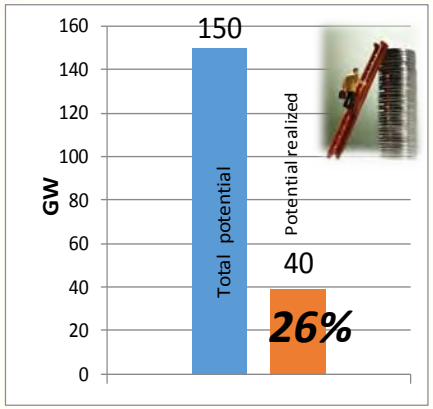
- **Answer to Climate Change** in Vulnerable regions

Hydropower- Burial Ground in midst of endless debate

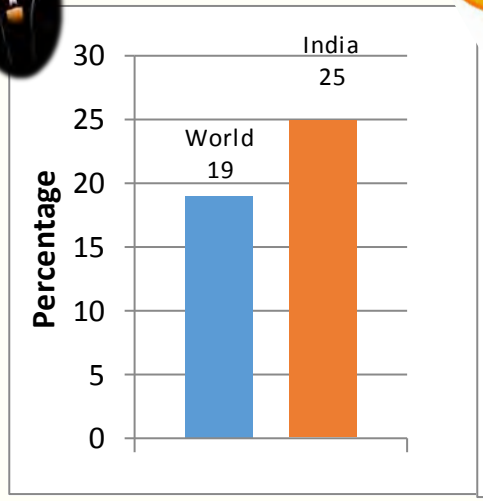
- Severe power shortage : Greatest **obstacles to India's development**.
- **Over 40 percent** of the country's people, most living in the rural areas **do not have access** to electricity
- **one-third of Indian businesses** cite *expensive and unreliable power* as one of their main **business constraints**.
- India's energy **shortfall of 10 percent** (rising to 13.5 percent at peak demand) also works to keep the **poor entrenched** in poverty.



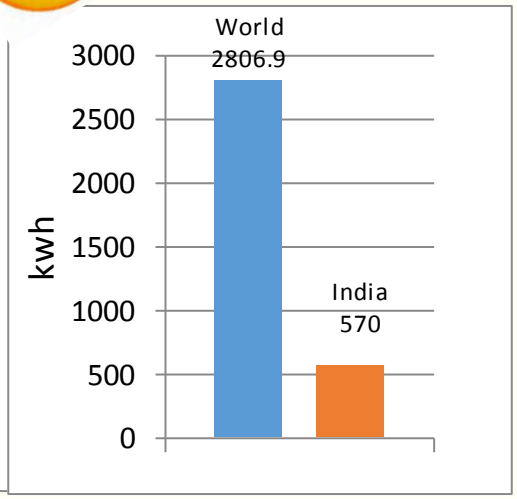
HYDRO POWER – ACHIEVEMENT IN INDIA



26% HYDROPOWER POTENTIAL HARNESSED



Percentage of population without electricity



Electricity consumption per capita per year

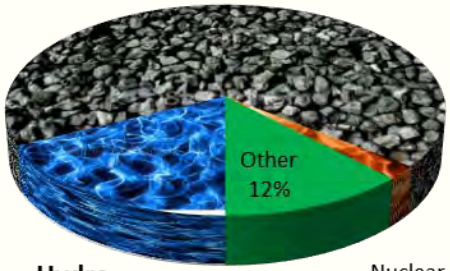
Year 2012-2013	Energy	Peak
Increase in Demand	6.5 %	4.2 %
Increase in Supply	6.2 %	6.1 %
Deficit	**8.7 %**	**9 %**

Sources – World Bank, Ministry of power (India)


Don't Drag Hydro Power in Graveyard
NO
NO
NO
NO
HYDRO POWER
Act now!

Accelerated Development of Hydropower – Need of an hour to act before it's too late

- ✓ For the **Indian economy** **to grow at 9% annually**, **additional capacity of 60 GW** must be added every five years
- ✓ Government's promise of **100% electricity** to domestic users will also push up consumption
- ✓ Reducing gap between **actual & ideal hydro**: thermal ratio of **40:60**



Hydropower's Share in Overall Power Generation in India

Hydropower development plan of India

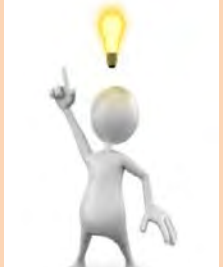
- ✓ In total, *399 potential projects* were identified which it aims to ***exploit by 2025***

YES WE CAN…

Mammoth Task → Overcome Challenges → Ground Reality

The 715 MW Francis-turbine

But How?



Through a typical Innovative “7 M” Model - A key to success (irrespective of project’s magnitude)

An Innovative "7M model"

Devised on basis of practical difficulties & experiences of success stories

Mid-course correction

Money

Master Plan

Machinery / **M**aterial

Moment

Manpower

Monitoring

Structure of 7 M Model

ASPECTS OF THE MODEL

Aspects influencing the functionality of 7M model:

- *Reliable and Bankable Detailed Project Report*
- *Construction Management*
- *Geological Surprises and Challenges*

Technical

- *Government Clearances*
- *Selection of Project Developer*
- *Law & Order / Militancy problems*
- *R&R issues*
- *Training of Manpower*

Policy

Aspects of 7M Model

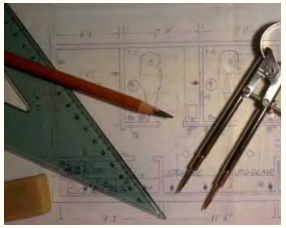
Financial

- *Adequate & continuous Fund for Hydropower development*
- *Relaxation of Duties &Royalties*

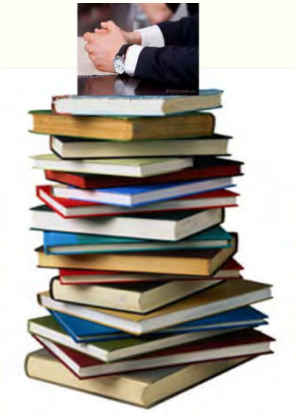
Infrastructure

- *Approach Roads & Logistics*
- *Equipment Mobilization*
- *Power Supply*
- *Construction Materials*

TECHNICAL ISSUES



Infuse confidence in Investor and Developer



Reliable and Bankable Detailed Project Report

Meet the outcomes of investigations and ground realities

Construction Time

Construction Management and Construction Technology

Technical issues

Geological Surprises and Challenges

- Stability of Rock Slopes
- *Assessment of foundation Condition*
- Locating construction materials
- Construction of Surface Power houses
- Tunnelling in uncertain rock conditions

Infrastructural Issues

Approach Roads & Logistics

+

Equipment Mobilization

+

Power Supply

+

Construction Materials

→ Infrastructural Issues

FINANCIAL ISSUES

- Financial Issues
- Custom Duty for Hydro Projects
- Fund for Hydropower Development
- Heavy Construction Cost of Roads and Bridges in Inaccessible Projects Sites
- Expenses on Security
- Royalty

POLICY ISSUES

- Time Frame for Clearances
- Selection of Project Developer
- Trans-boundary issues
- Private Land Acquisition
- Law & Order Problems
- Rehabilitation & Resettlement (R&R)
- Public and Private Sector Participation in Hydropower Development
- Technical Knowledge Development
- Adequate Experienced Construction Manpower (Technical and Managerial)
- Competent Indigenous Construction Agencies

MONEY

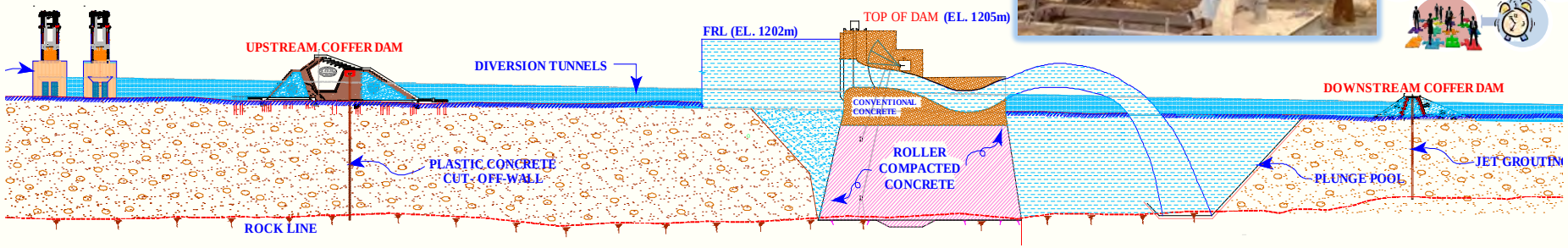
- Creation of **Special-purpose funding vehicle**, "Corpus Fund"
- Investment **attracting concession agreements** to attract big players in hydropower development
- A **clear road map** for **encouragement of Public private partnership (PPP)**
- **Exclusion** of **cost of access roads** from project cost, as development of hydro projects triggers economic and commercial activities around the project site and results in economic benefit to the Nation
- **Cost of security** may be borne by the Nation in troubled areas and infested by militancy and terrorist activities
- **Exemption of royalty** on construction material
- **Relaxation in custom duty** for imported equipment and machinery for projects

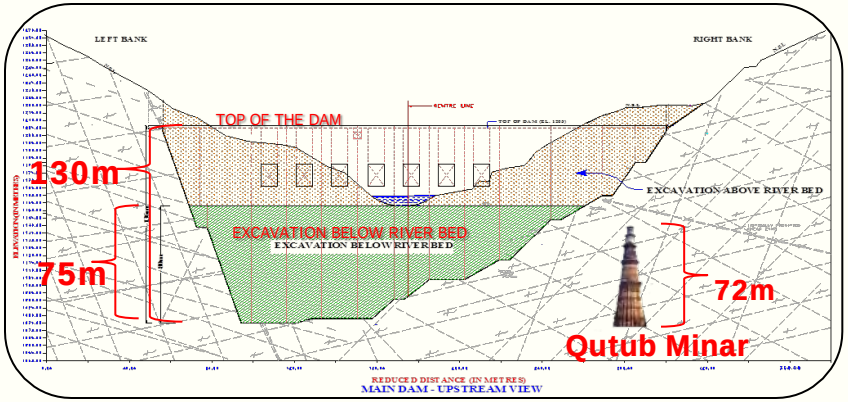
Master Planning/Project Planning

- **Reliable, Realistic** and **Bankable** Detailed Project Report
- **Squeezing gestation period** between DPR stage and Tendering Stage (including award of work) by accelerating start of pre-construction activities
- **Resolution of trans-boundary disputes** within the DPR stage only
- **Set up single window clearance** for hydro projects **within six months** of the submission of proposal.
- **Selection of Project Developer** i.e. Private Developer or Government Agency
- **Capacity building** for **development of competent** indigenous **Agencies and Manpower** including technical knowledge development
- Address to **Clear** and **community oriented R & R policy**

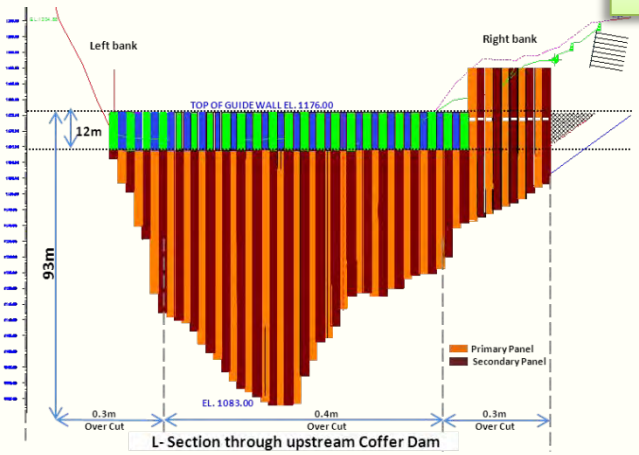
Implementation of 7 M Model

Machinery

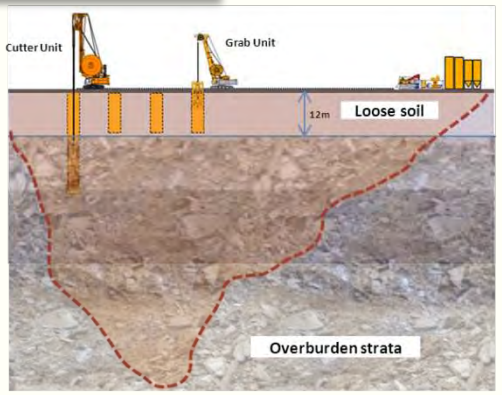




With Cut-Off wall



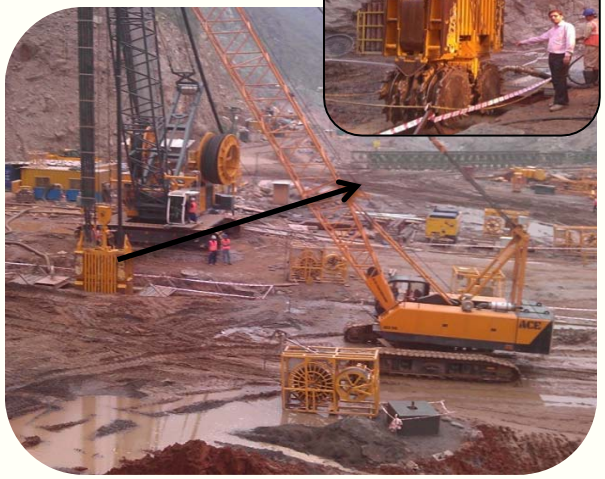
L- Section through upstream Coffer Dam

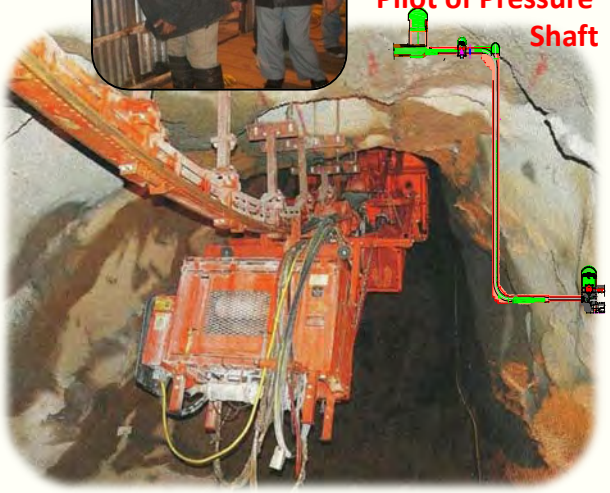


Mode of Panel excavation (Depth wise)

Machinery

- Use of the **latest State of Art Technology** specific to project

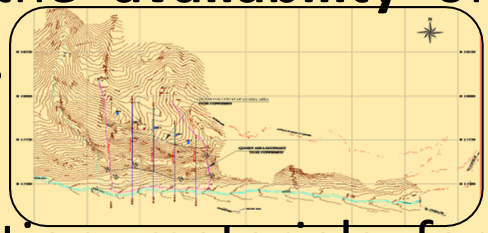




- **Brand new equipment procured** on behalf of contracting agency prior to mobilization

Material

- **Detailed** planning and **identification** of the **availability** of **construction material** prior to construction.



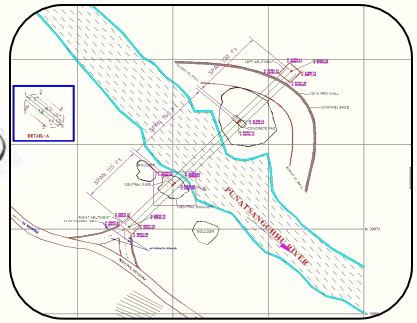
- Adequate **laboratory testing** of construction materials for **checking suitability** prior to **construction stage.**

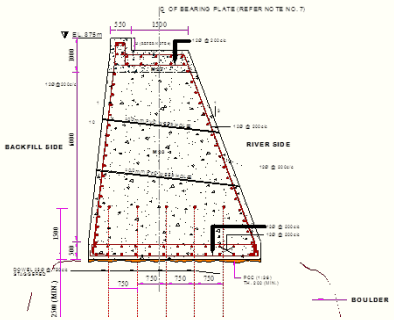
- **Infrastructure ready** for exploiting **quarries.**

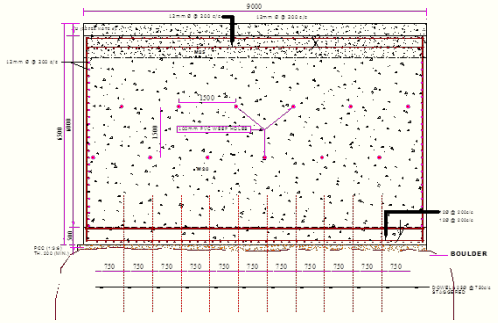
- **Supply** of the **construction material** to contracting agency.

Moment (Time Frame)

- **Pre-construction activities** to be completed prior to award of works
- **Construction of Roads and bridges** to be constructed by the Project Developer prior to award of works







- **Conceptualization, Planning & Layout**
- **Topographical surveys**
- **Design & Tender Engineering**

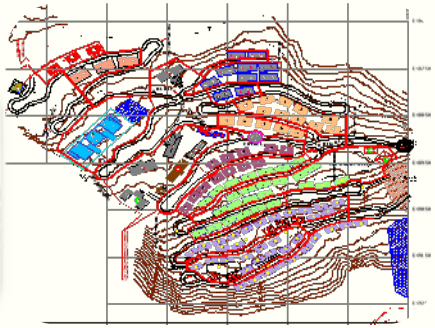
- **Technical Assistance during Construction**

Implementation of 7 M Model

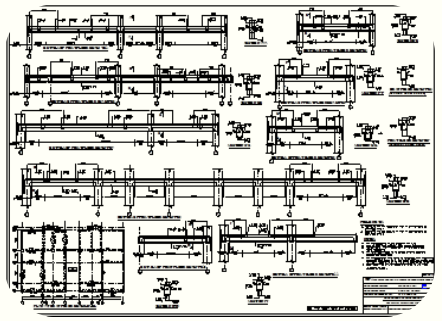
Moment

- **Contractor facilities** such as officer / labor accommodation
- Provide **Power Supply** to meet the Contractor's needs at site.

- **Conceptualization & Master Planning**



- **Topographical surveys**



- **Design Engineering & Detailed designed engineering**

- **Infrastructure Services**

- **Tender Engineering**

- **Technical Assistance during Construction**

Implementation of 7 M Model

Moment

- **Squeezing Construction time** with appropriate **Construction Management** technique and **Construction Technology**

Roller Compacted Concrete (RCC) Technology in Dam construction

Manpower

- **Sufficient numbers** should be assured throughout the project
- **Competent** manpower for smooth running of project

Monitoring

- For efficient running of project, **stringent monitoring** is required.
- Proposed model:

3 Tier model for monitoring

- **Monthly In-house meetings**
- **Monthly meetings with Contractor**
- **Monthly meetings with Consultants**

Mid Course Correction

- **Review** of **project implementation** responsive to geological surprises – **without moment's hesitation**

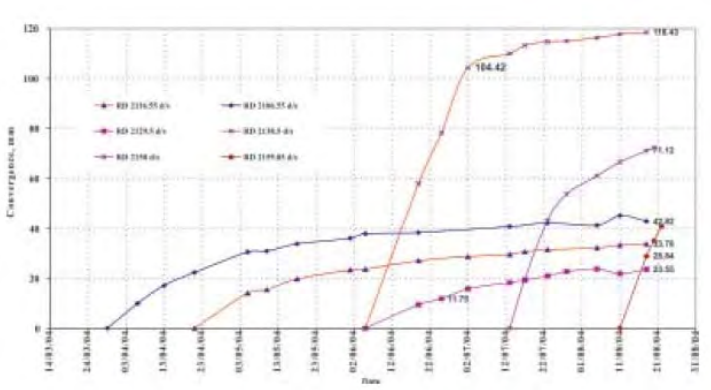
Lining of forepoled AGO reach of HRT

Problem

- The strata encountered in the realigned HRT reach – squeezing ground conditions and flowing rock mass

Flowing rock mass

- Lining of HRT for this specific reach – increasing rate of convergence & Rock loads - leading to the reach of instability

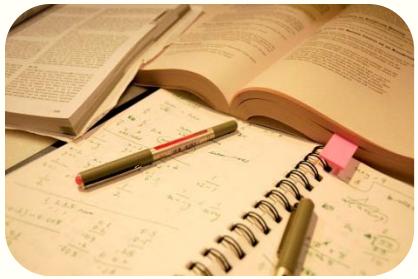


Convergence curve

Lining of forepoled AGO reach of HRT

An idea : Design Lining of HRT for the entire rock load

Study :



- Worked out the rock loads induced over the ribs based on the instrumentation data of load cells & convergence – *Design memo*

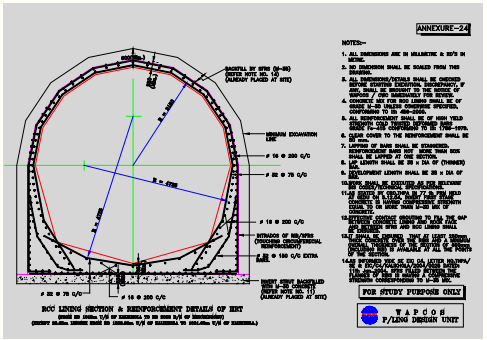
  Carried out detailed stability analysis for the forepoled reach – *Design memo*

- Analysis & design of RCC lining of HRT – Using Conventional approach & STAAD model

  - *Design memo*

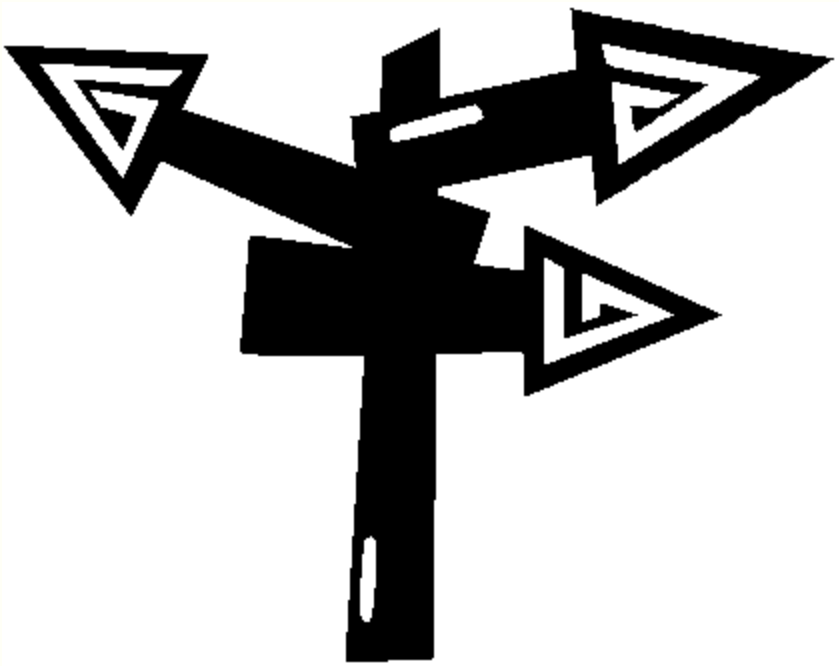
Action : 32mm dia. @ 75mm c/c on both faces

Reinforced tunnel



Rating : A hit solution

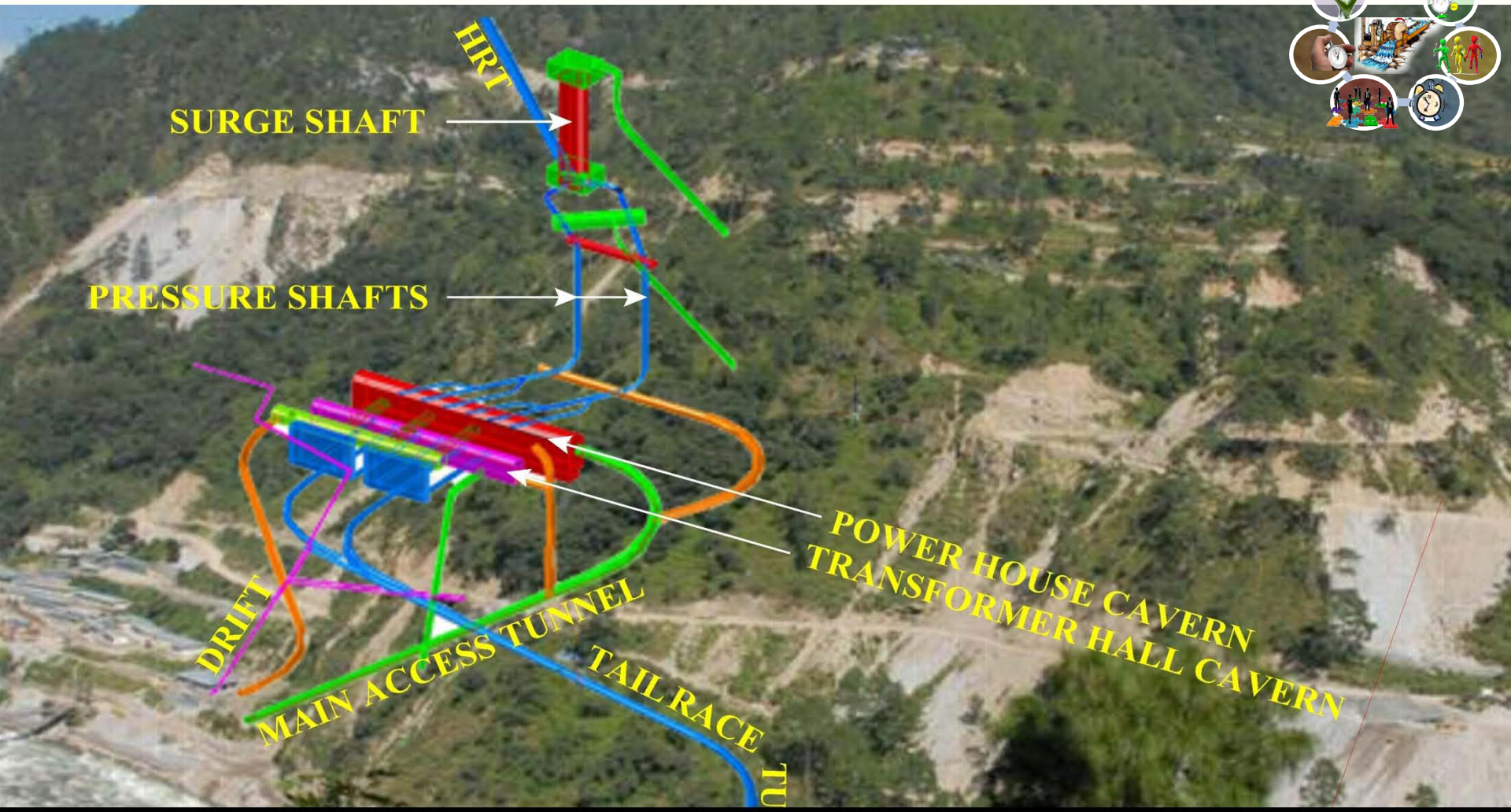
- **Exploring all alternatives** - **design** and technology **during** the **construction stage** may serve as additional tool for mid course correction



- **Project Optimization** based on **Concurrent**

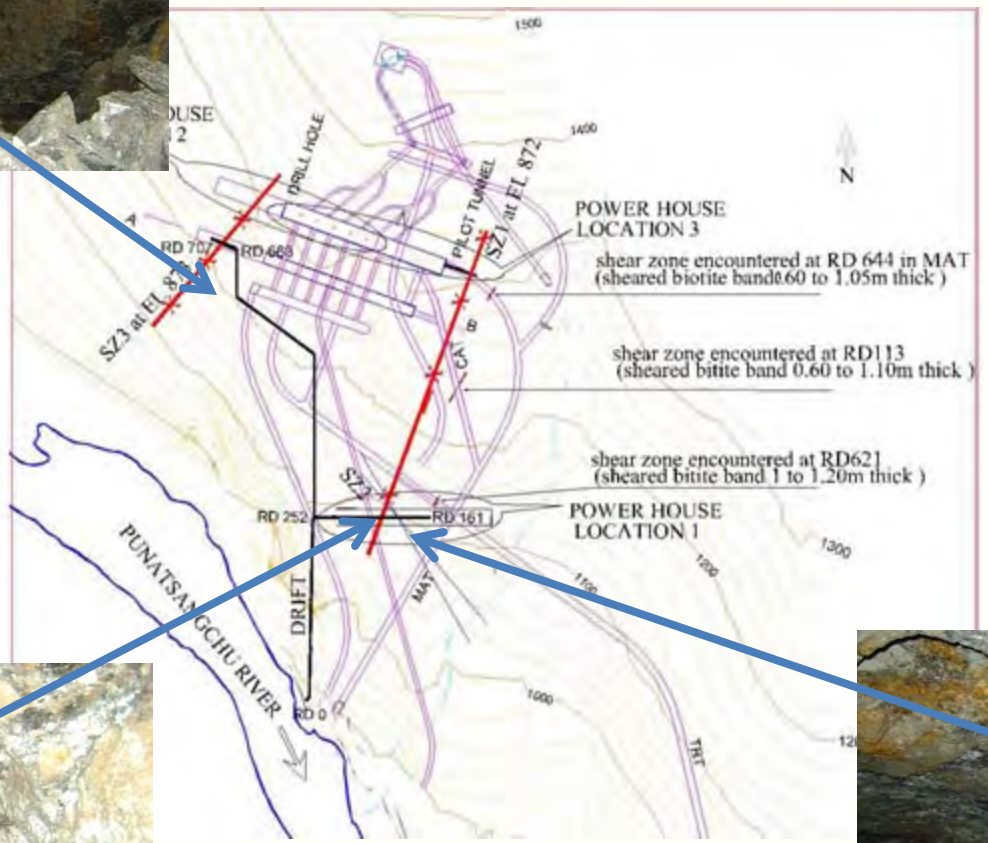
  Geological findings

POWER HOUSE COMPLEX



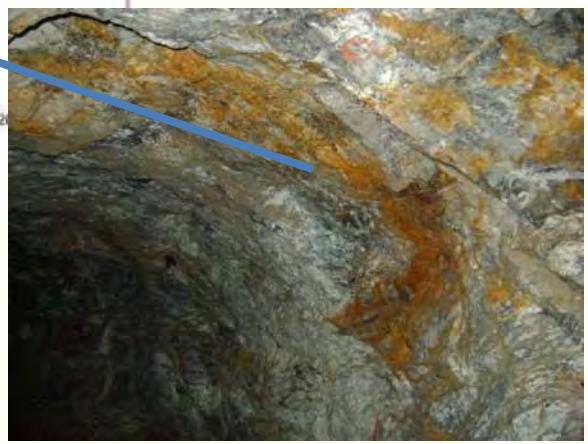
Location of Shear zones in Power House

SZ 3

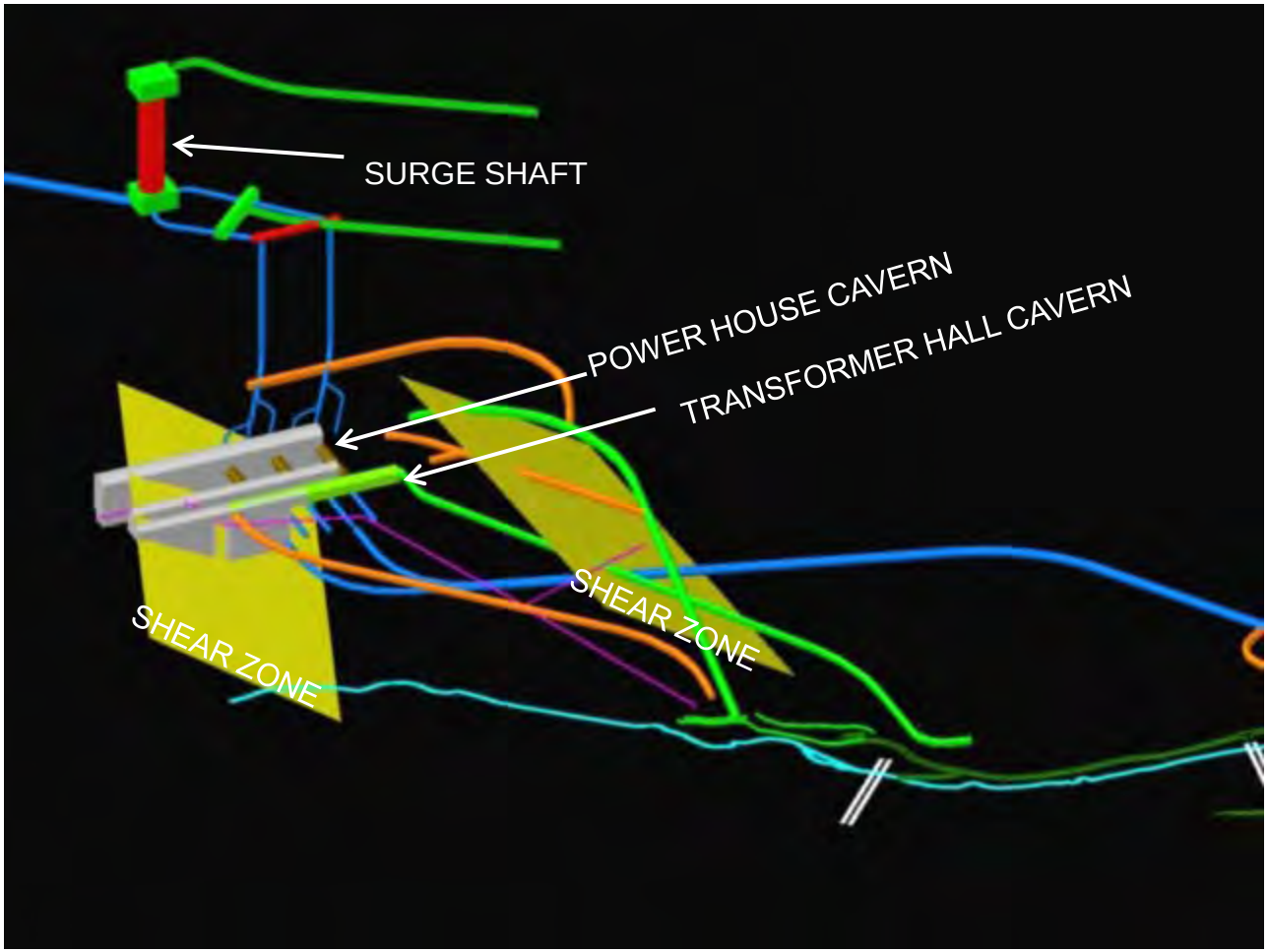


SZ 1

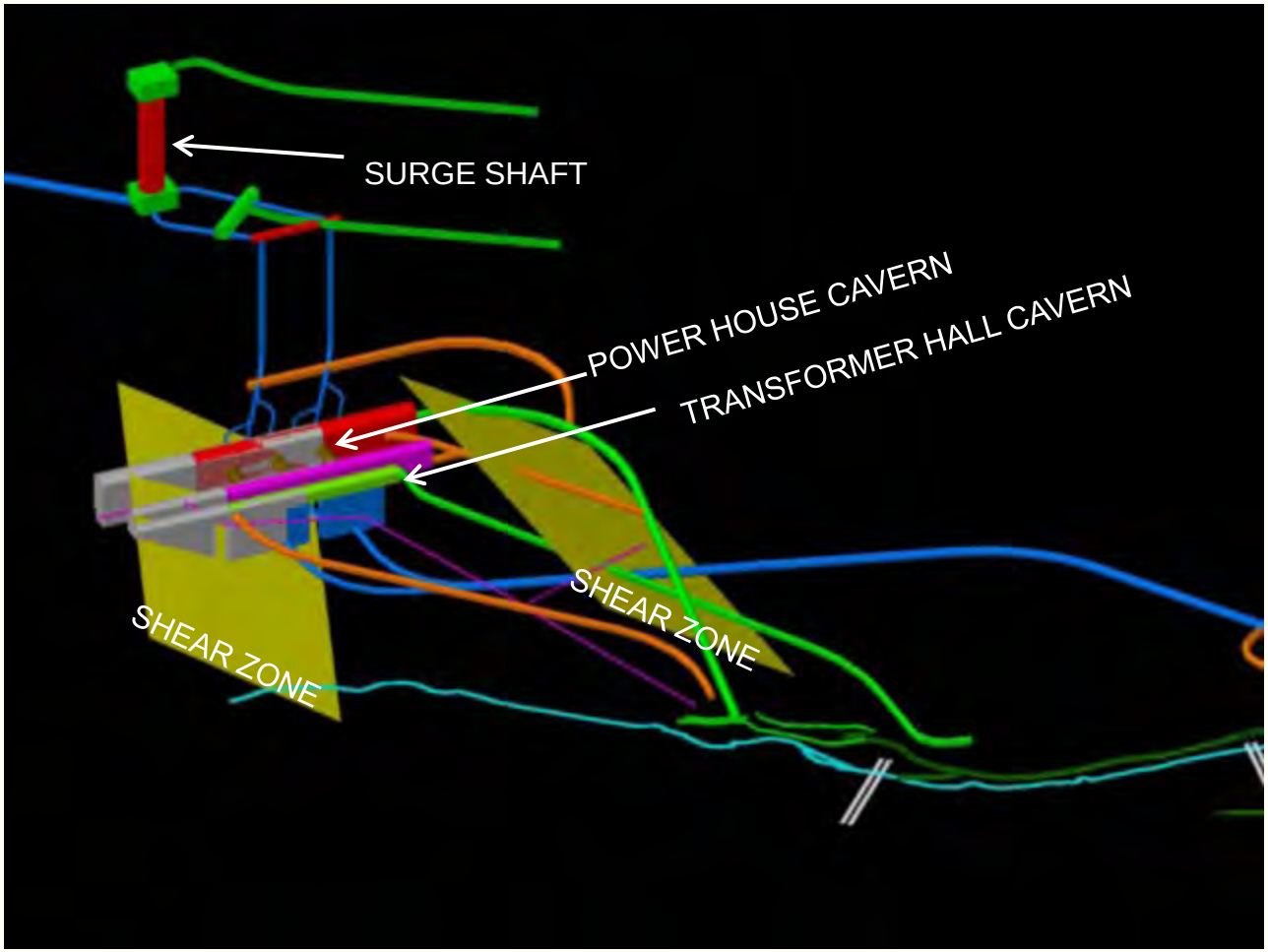
SZ 2



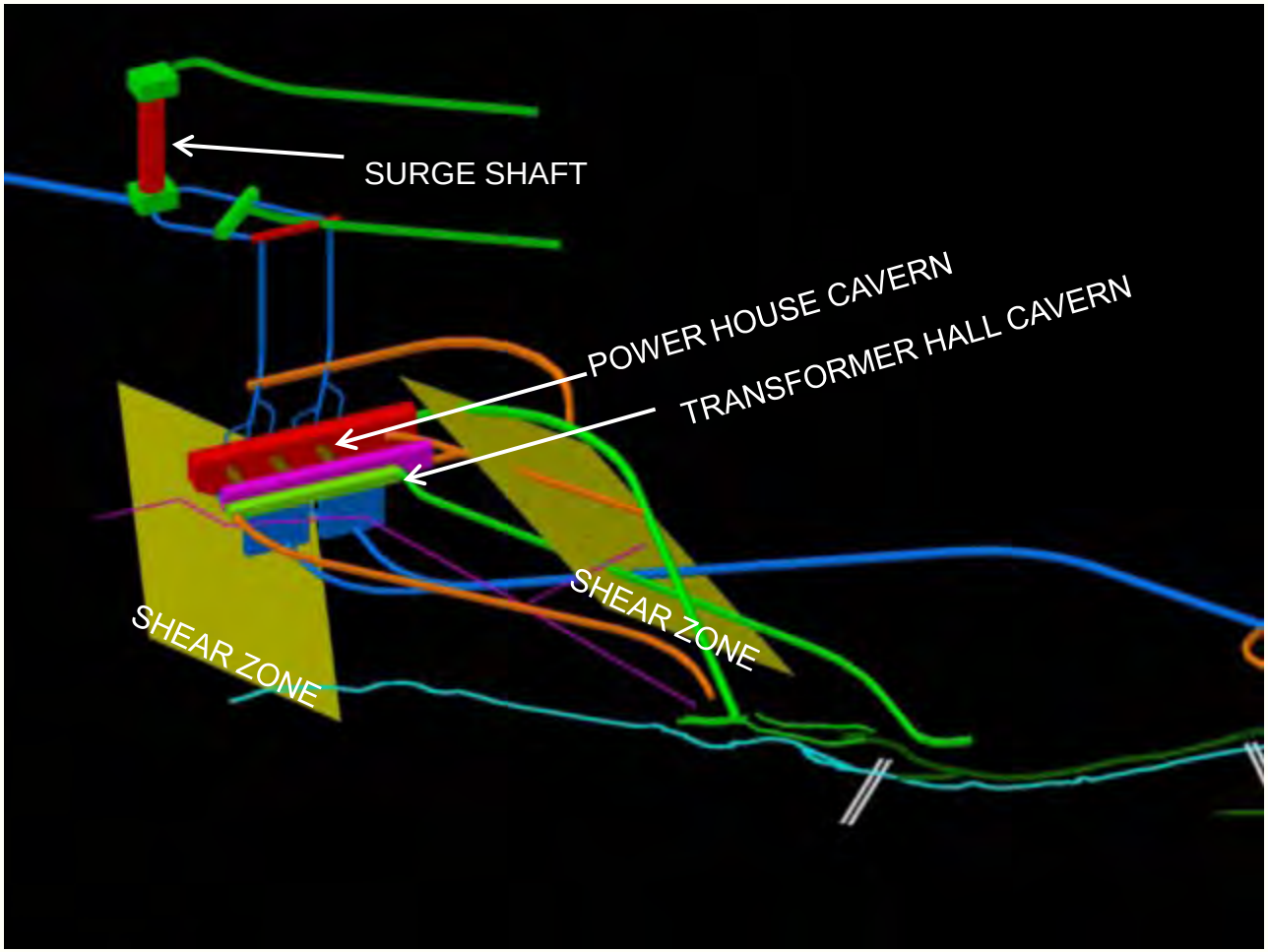
POWERHOUSE COMPLEX - *Original location*



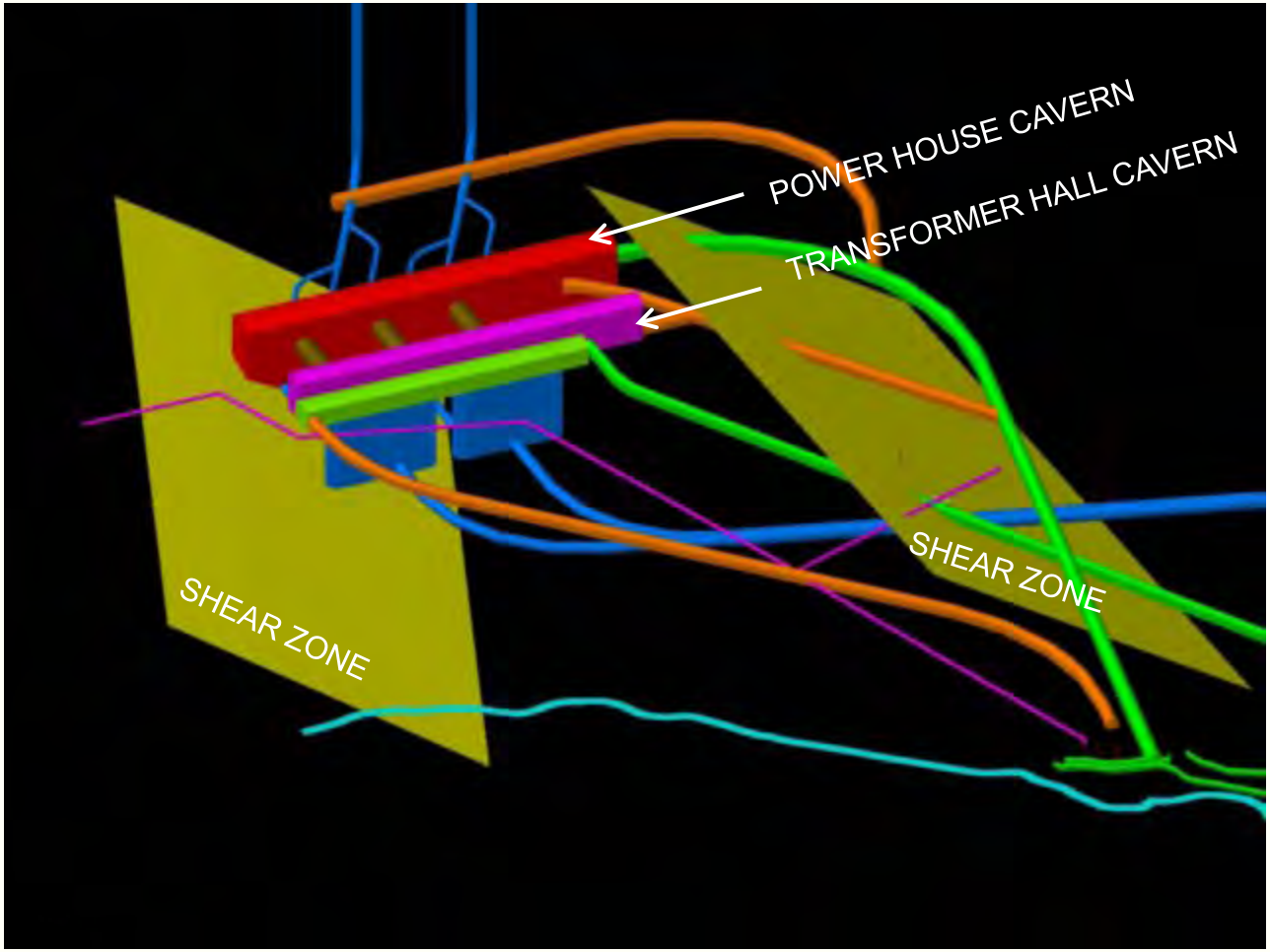
POWERHOUSE COMPLEX - *Original & alternate locations*



POWERHOUSE COMPLEX – *Alternate location*



POWERHOUSE COMPLEX – *Final location vis-à-vis shear zone*



A Mantra to success

The **7 M Model** i.e.

M

oney

aster Plan

achinery / Material

anpower

onitoring

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id-course correction

Key to successful and accelerated execution of hydropower projects, irrespective of magnitude

Conclusion…

- **Hydropower plants** : Banks of water & energy security

- Aid in unwinding wrath of climate change, besides ensuring food security through regulated irrigation releases

- Challenges tackled by rightful selection of protection, mitigation & enhancement measures.

- The complex interrelations of issues of hydropower development for food security in hard pressed changing climate must be weighed judiciously, with an unbiased prejudice of mind.

- To foster the generation of hydropower, at relatively faster pace, for making up for the already lost time, it necessitates use of innovative practices in planning, design & construction aspects, which is beaded in a typical model "7M MODEL"


Thank You


Thanks