TWAS Science Diplomacy Workshop

Sustainable Water Management

Trieste, Italy

Breakout Group Session II

Analysis by Water Sector : Agriculture and Run-off

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Task Assigned :

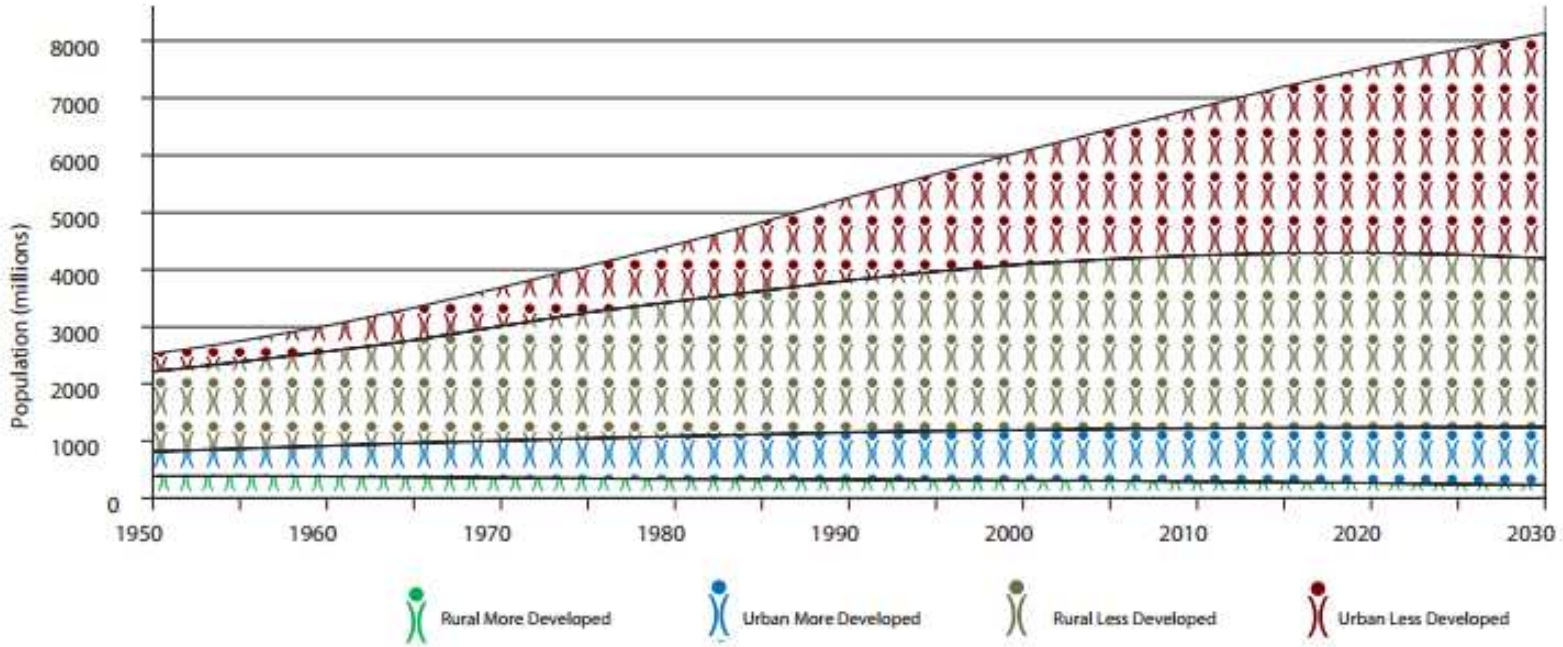
Pollution and Runoff

Agricultural and Industrial Use of Water

Understanding and Inventorization

Population Growth Projected to reach over 8 billion in 2030 and to level off at 9 billion by 2050.

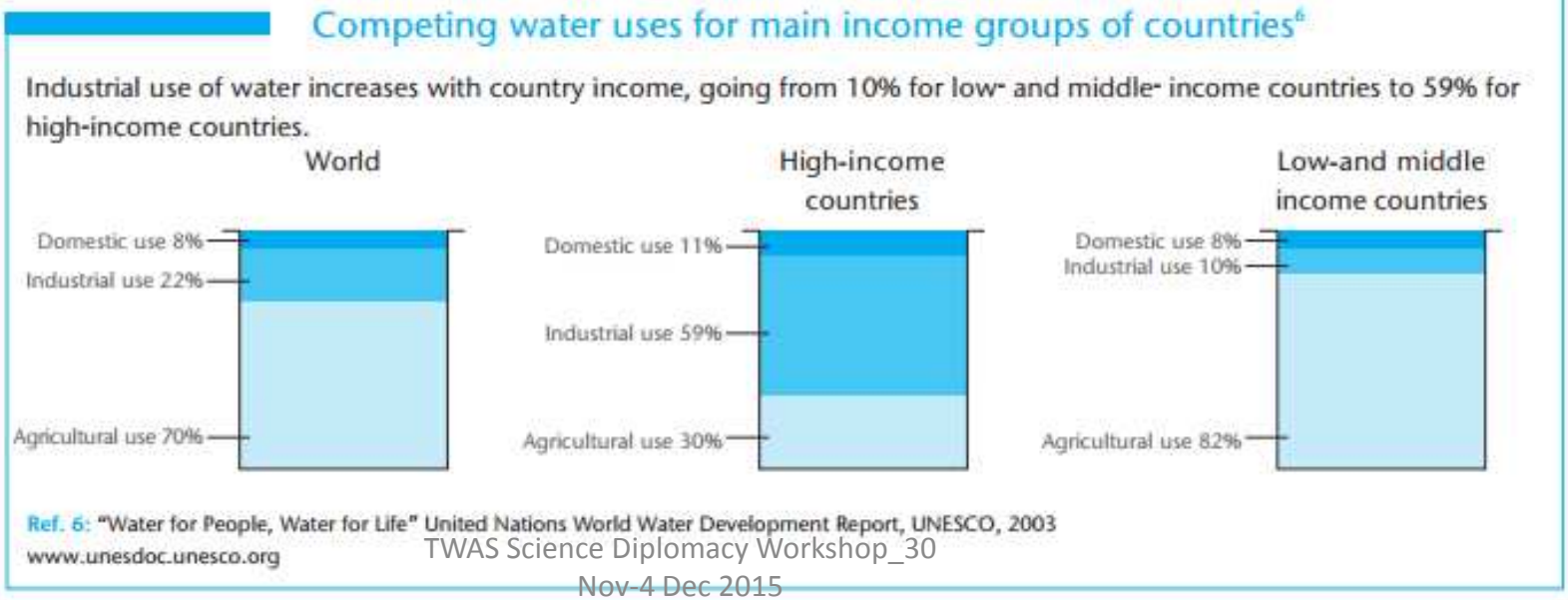
Population trends 1950 - 2030



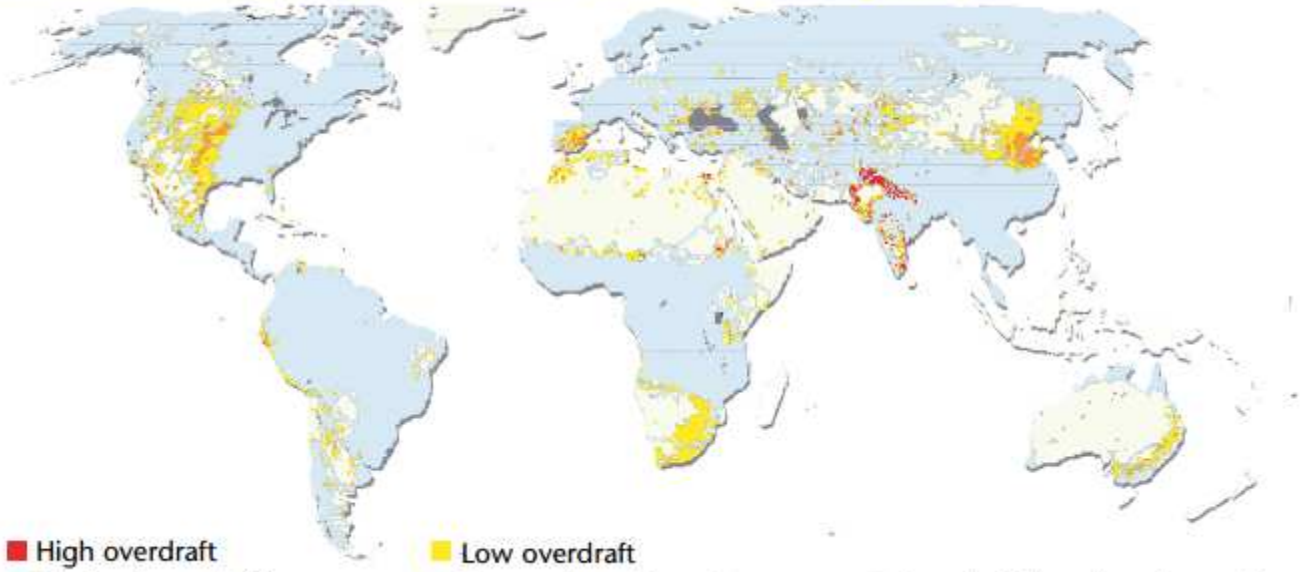
Source: UN DESA, World Urbanization Prospects: 2003 Revision

Agriculture is by far the largest consumer of the Earth's available freshwater: 70% of "blue water" withdrawals from watercourses and groundwater are for agricultural usage, three times more than 50 years ago. By 2050, the global water demand of agriculture is estimated to increase by a further 19% due to irrigational needs. **(http://www.globalagriculture.org/report-topics/water.html)**

Who Uses Fresh Water

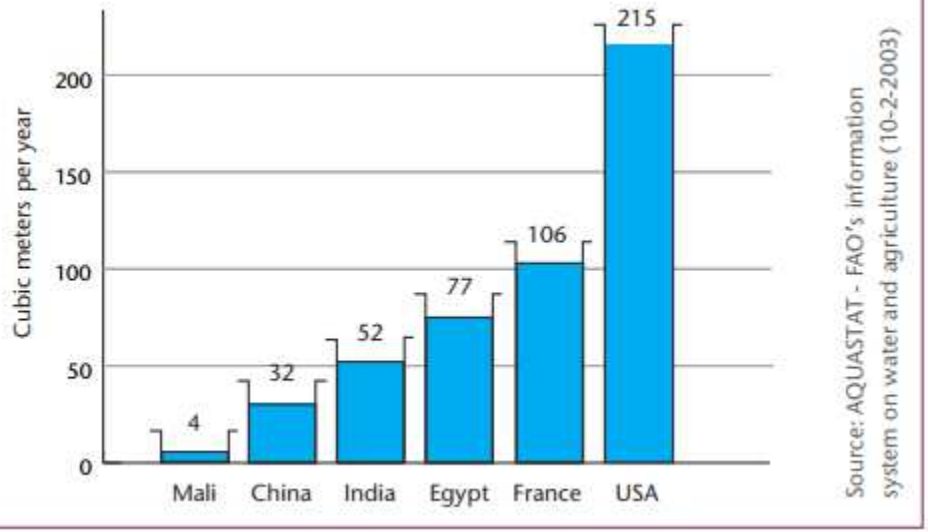


Unsustainable water withdrawals for irrigation[7]



Per capita use of water

The adjacent chart derived from Aquastats data shows the wide variation in average per capita water withdrawals for domestic use from different nations. Humans need a minimum of two liters of drinking water per day to survive, which is less than one cubic meter per year.



http://www.unwater.org/downloads/Water_facts_and_trends.pdf

After agriculture, industry is the second largest user of water. However the amount of water used varies widely from one type of industry to another.

[No water, no business]

Industry

Process water

Industry uses water to make steam for direct drive power and for use in various production processes or chemical reactions.

A modern paper mill in Finland has reduced the amount of water used per unit of output by over 90% over the last 20 years: thanks to change from chemical to thermo-mechanical pulp, and installation of a biological wastewater treatment facility that permitted recycling of water.

A modern microchip manufacturing plant in Malta was able to reduce its water consumption by over 70% in the late 1990s.

A textile firm in India reduced its water consumption by over 80%, by replacing zinc with aluminum in its synthetic fiber production, by reducing trace metals in wastewater thereby enabling reuse and by using treated water for irrigation by local farmers.

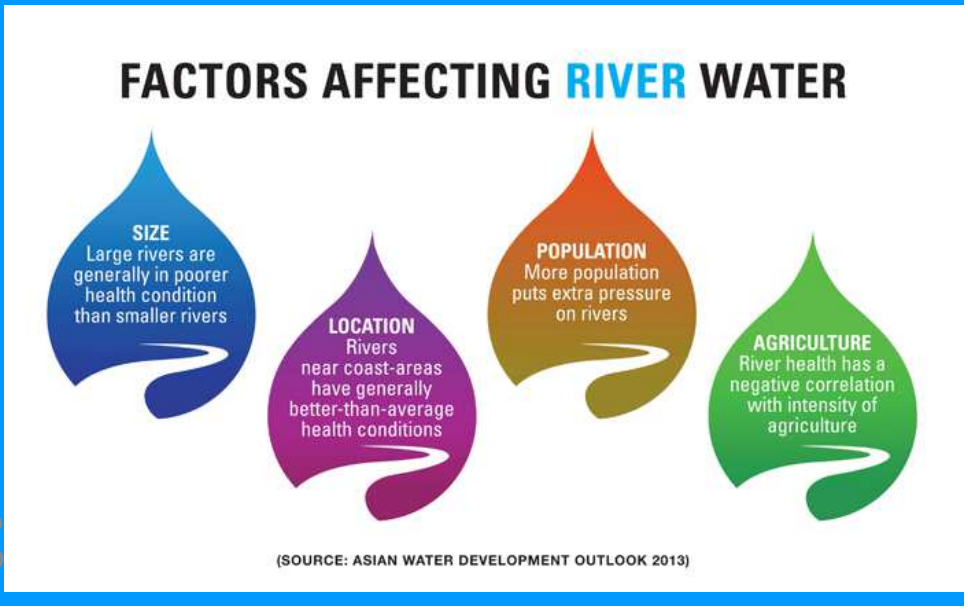
A plant converting sugar cane into sugar in Mexico reduced its consumption of water by over 90% by improving housekeeping and segregating sewage from process wastewater.

Water pollution

- **Water Pollution:**
  - Definition Water pollution is the contamination of water bodies e.g. lakes, rivers, oceans, aquifers and groundwater. Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove h
- **Water Pollution Causes by…**
  - Marine Dumping
  - Industrial Waste
  - Sewage
  - mainly from households
  - Nuclear waste
  - Oil pollution
  - Underground storage leaks
- **Water Pollution Effects:**
  - Diseases like Cholera, Malaria,
  - Typhoid (spread during the rainy season), Aquatic life gets destroyed.

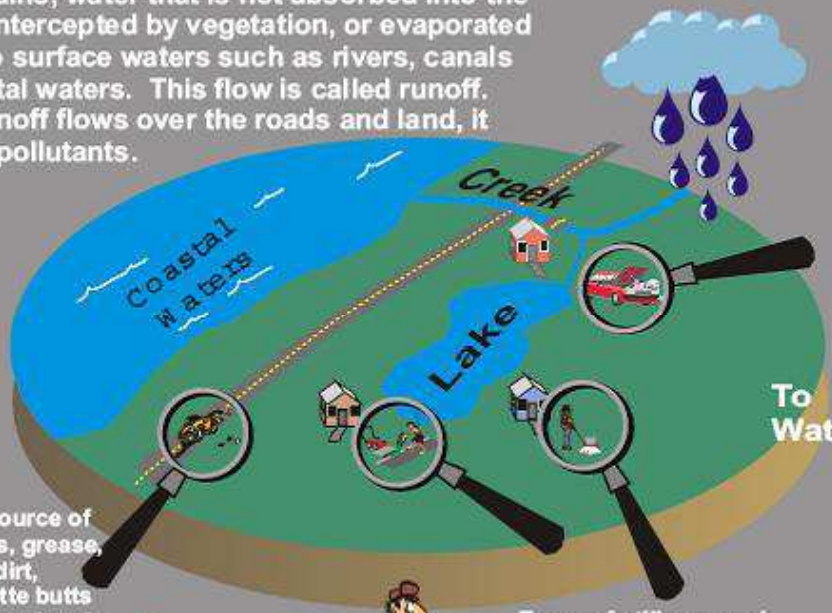
Environmental Concerns

- Primarily non-point source (NPS) water pollution
  - Collective run-off from an area (picture depicts sediment from a large construction site)
  - Ag NPS could be from animal confinement & manure storage; chemical/fuel storage; fields; farm roads…

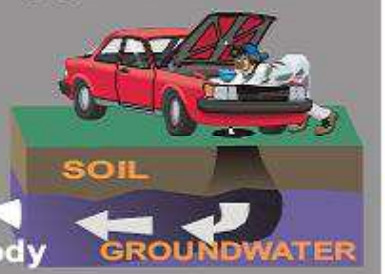


The CULPRITS

When it rains, water that is not absorbed into the ground, intercepted by vegetation, or evaporated flows into surface waters such as rivers, canals and coastal waters. This flow is called runoff. As the runoff flows over the roads and land, it picks up pollutants.



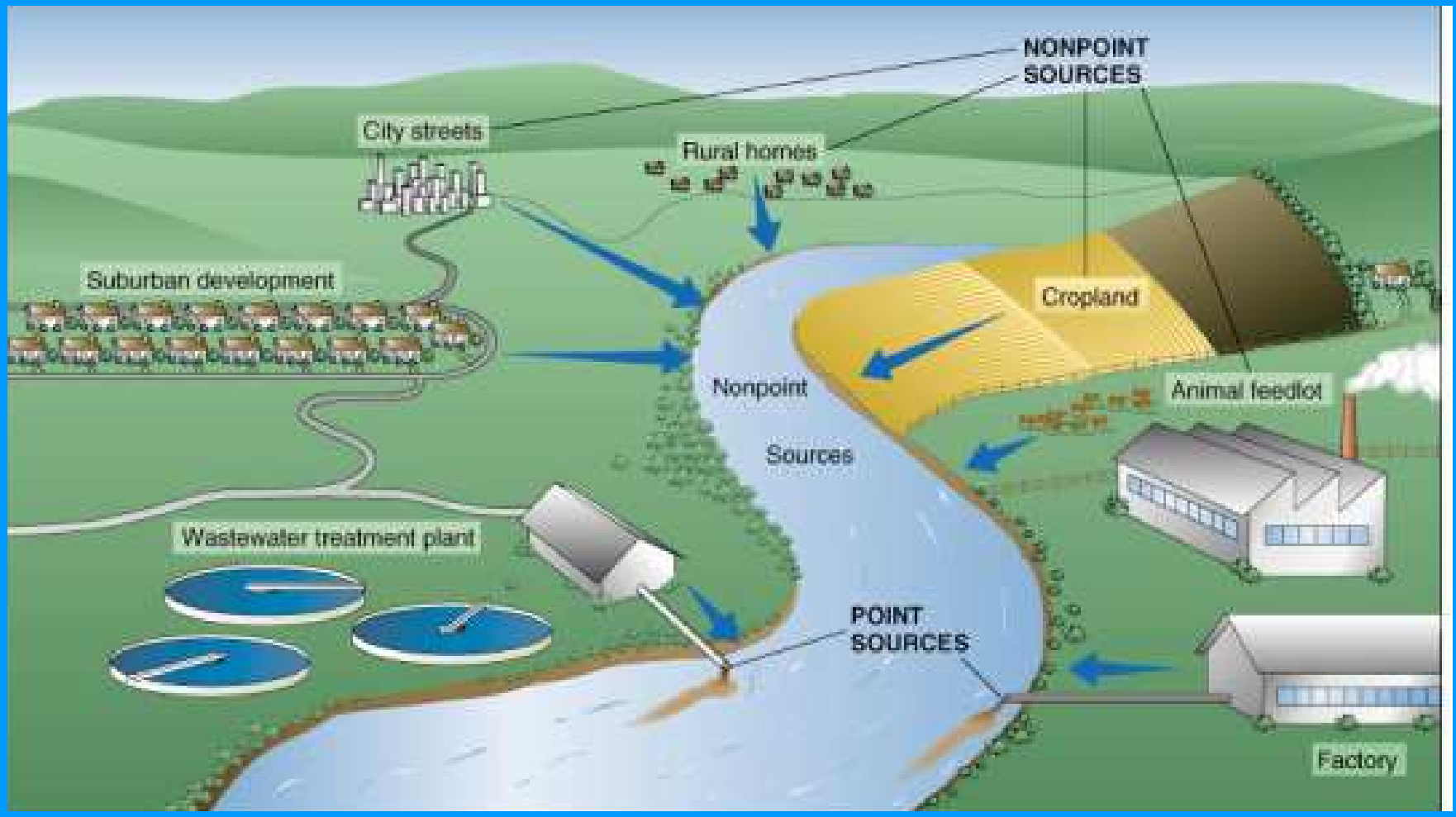
Surface water can be polluted through groundwater.

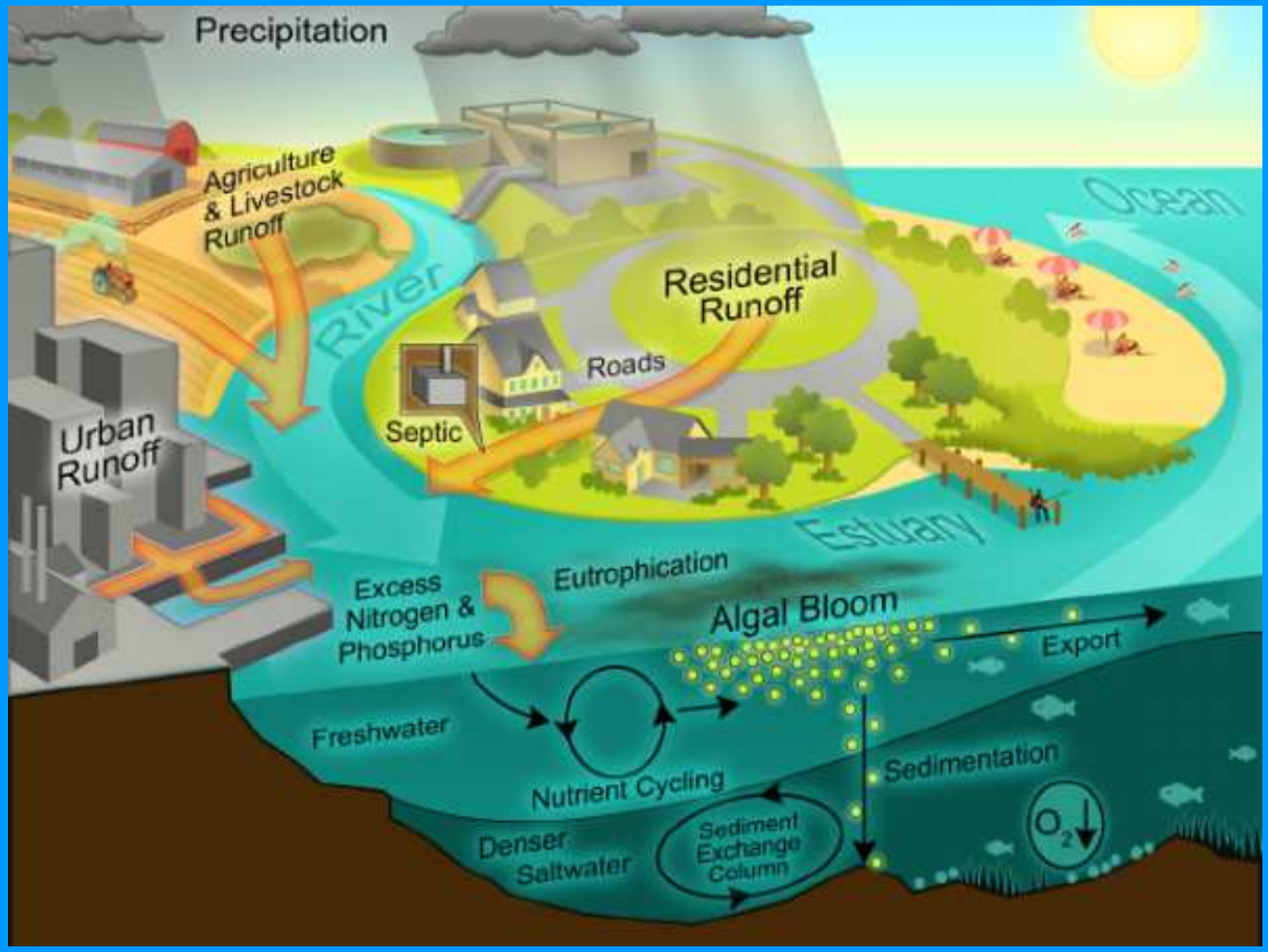


Roads are a source of pollution. Oils, grease, construction dirt, trash & cigarette butts wash off roads when it rains.

Excess fertilizers wash off lawns & gardens when it rains & flow into surface water.

Things put into stormdrains and on the street can end up in our rivers, canals, & coastal waters


NONPOINT SOURCES
City streets
Rural homes
Suburban development
Cropland
Nonpoint
Sources
Animal feedlot
Wastewater treatment plant
POINT SOURCES
Factory


Precipitation
Agriculture & Livestock Runoff
River
Residential Runoff
Ocean
Roads
Septic
Urban Runoff
Estuary
Excess Nitrogen & Phosphorus
Eutrophication
Algal Bloom
Export
Freshwater
Nutrient Cycling
Sedimentation
Denser Saltwater
Sediment Exchange Column
O_2

17 RED CATEGORY INDUSTRIES

- Distillery including Fermentation industry
- Fertiliser
- Dyes and Dye Intermediates
- Petrochemicals
- Sugar
- Pulp & Paper
- Pharmaceuticals
- Fertilisers and Pesticides
- Tanneries
- Thermal Power Plants
- Organic solvent, chlorinated minerals
- Heavy and large industries
- Inorganic chemical industries
- Oil Refinery
- Phenols and related industries based on coalta distillation
- Iron & Steel
- Copper Smelter

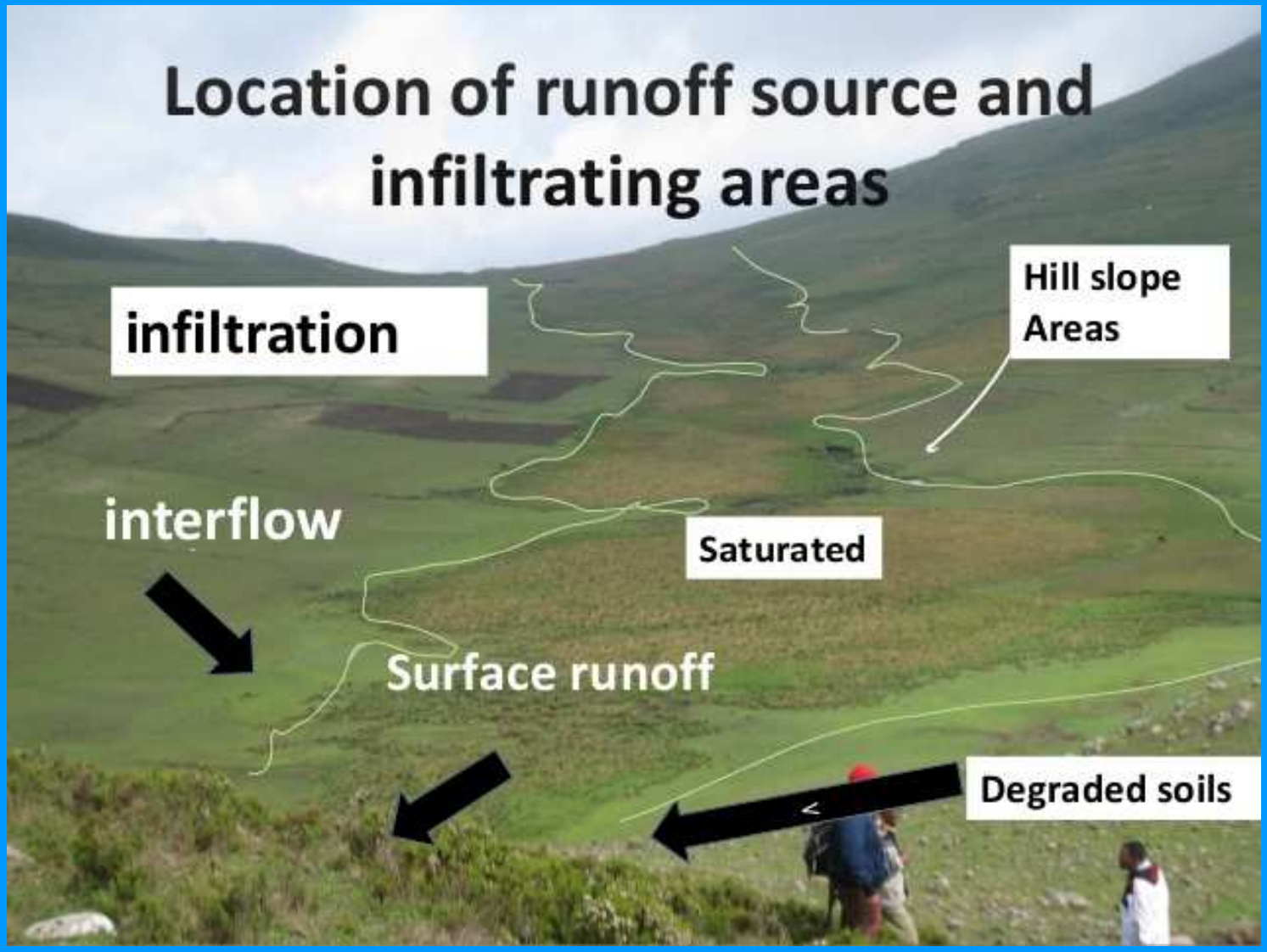
Control of water pollution

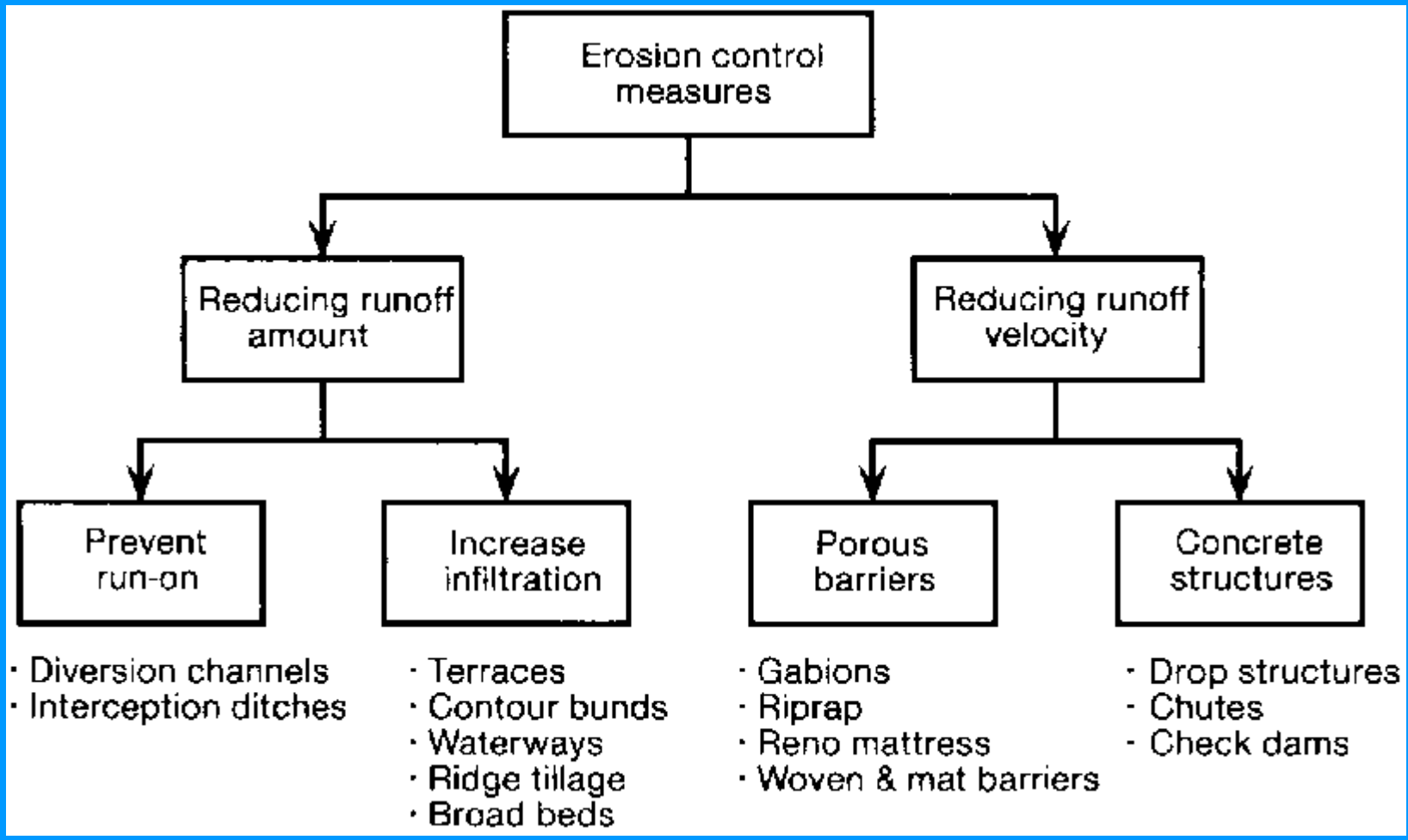
- It is easy to reduce water pollution from point sources by legislation. However it is difficult to prevent water pollution from non-point sources,

Judicious use of agrochemicals like pesticides and fertilizers which will reduce their surface run-off and leaching. Avoid use of these on sloped lands.

AGRICULTURAL WASTES

- Chemical fertilizers and pesticides have become essential for present day high yielding crops.
- Consequently , they have become a potential source of water pollution. These fertilizers contain major plants nutrients mainly nitrogen, phosphorous, and potassium.
- Excess fertilizers may reach the ground water by leaching or may be mixed with surface water of rivers, lakes and ponds by runoff and drainage.


Location of runoff source and infiltrating areas
infiltration
Hill slope Areas
interflow
Saturated
Surface runoff
Degraded soils


Erosion control measures
Reducing runoff amount
Reducing runoff velocity
Prevent run-on
Increase infiltration
Porous barriers
Concrete structures
· Diversion channels
· Interception ditches
· Terraces
· Contour bunds
· Waterways
· Ridge tillage
· Broad beds
· Gabions
· Riprap
· Reno mattress
· Woven & mat barriers
· Drop structures
· Chutes
· Check dams

FARM PROCESS—Features and Capabilities

Farm Demand—Irrigation

Non-Routed Deliveries—Water Transfers

Routed Surface-Water Delivery

Groundwater Pumpage

Streamflow Conveyance & Drain Network

Natural and Artificial Recharge

Water-Use Management

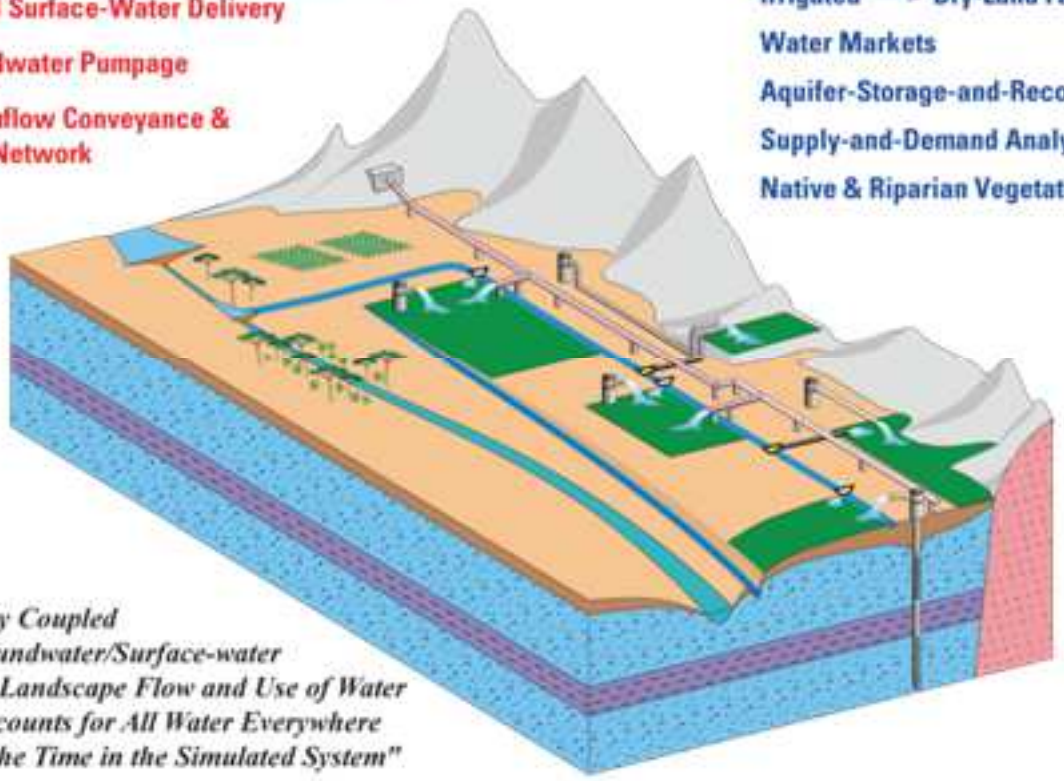
Irrigated —▷ Dry-Land Farming

Water Markets

Aquifer-Storage-and-Recovery Systems

Supply-and-Demand Analysis

Native & Riparian Vegetation



Fully Coupled Groundwater/Surface-water and Landscape Flow and Use of Water "Accounts for All Water Everywhere All the Time in the Simulated System"

Importance of Agricultural Runoff

- Water sources are a vital part of ecosystems.
  - Source of drinking water and homes for water-dependent organisms.
  - With contaminated water, many organisms are negatively affected.
- Nitrogen and Phosphorus from fertilizers help oxygen-depleting algae grow.
  - Why is this important? Reduces the amount of oxygen available for other sea creatures.
- **Red Tides**:
  - Also known as algal blooms.
  - Process in which algae (phytoplankton) rapidly accumulate in water.
  - Why is this important? Outbreaks of life-threatening diseases and poisoning to marine animals.
- **Dead Zones:** Areas of bodies of water that lack enough oxygen to sustain much life.
  - Can harm fish industry.

WATERSHED DEVELOPMENT

Possible range of treatment measures

- Contour bunding
- Contour trenching
- Contour stone walls
- Bench terraces
- Land levelling
- Summer ploughing

Way Forward

Research And Development

Policy Making

Deployment

aim at protecting water resources
(* surface and ground water
**** Qualitative & Quantitative)***

Pollution and RUN-off


INNOVATION

Agriculture & Industry

More Emphasis and focus on :

- **Research to address issues at regional and national level**
  - ❑ **Development of Technologies for reducing water demands sector wise and there by reducing water pollution**
    - ✓ **Industry : process change, reuse : cooling systems, Recovery, Advanced Treatment Processes, Clean and Green Technologies**
    - ✓ **Irrigation practices : root zone irrigation, drip irrigation, sprinkler system**

Viability

Agriculture: Growing demands -food security

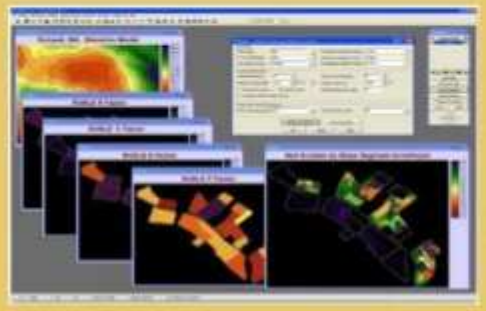
- Salt tolerant species
- Drought resistant species
- Genetically modified crops
- Alternative growing patterns
- More crop per drop
- Water requirements and growing crop condition
- Prediction models to address crop acreage yield estimations..

Run Off

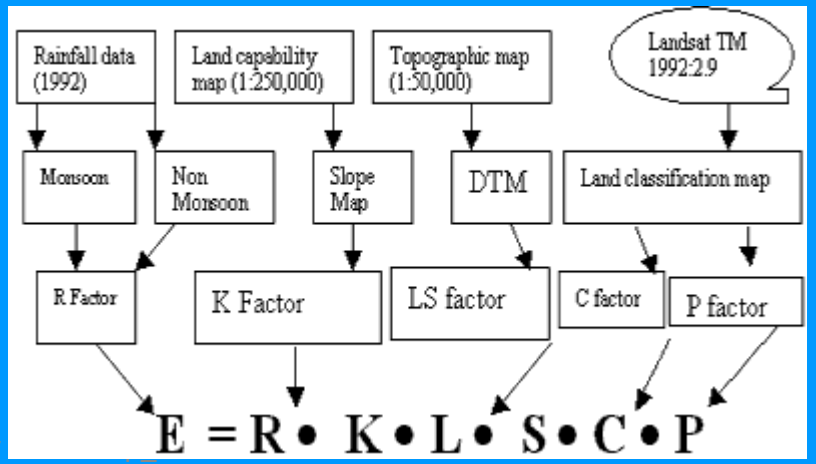

agricultural plains
quarry site or property development?
A choked point
Floodplains
Google earth

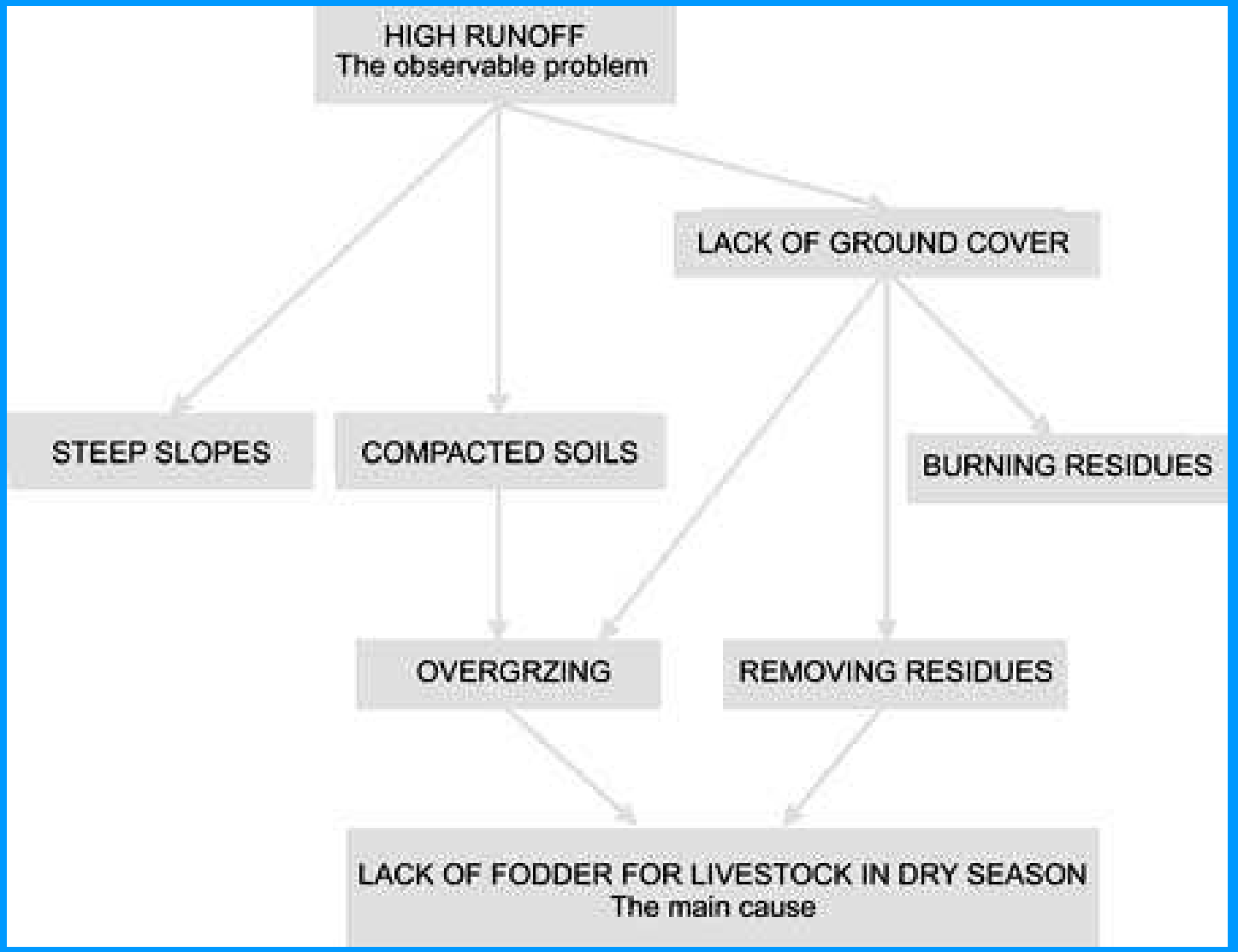
- Universal soil loss equation (USLE):

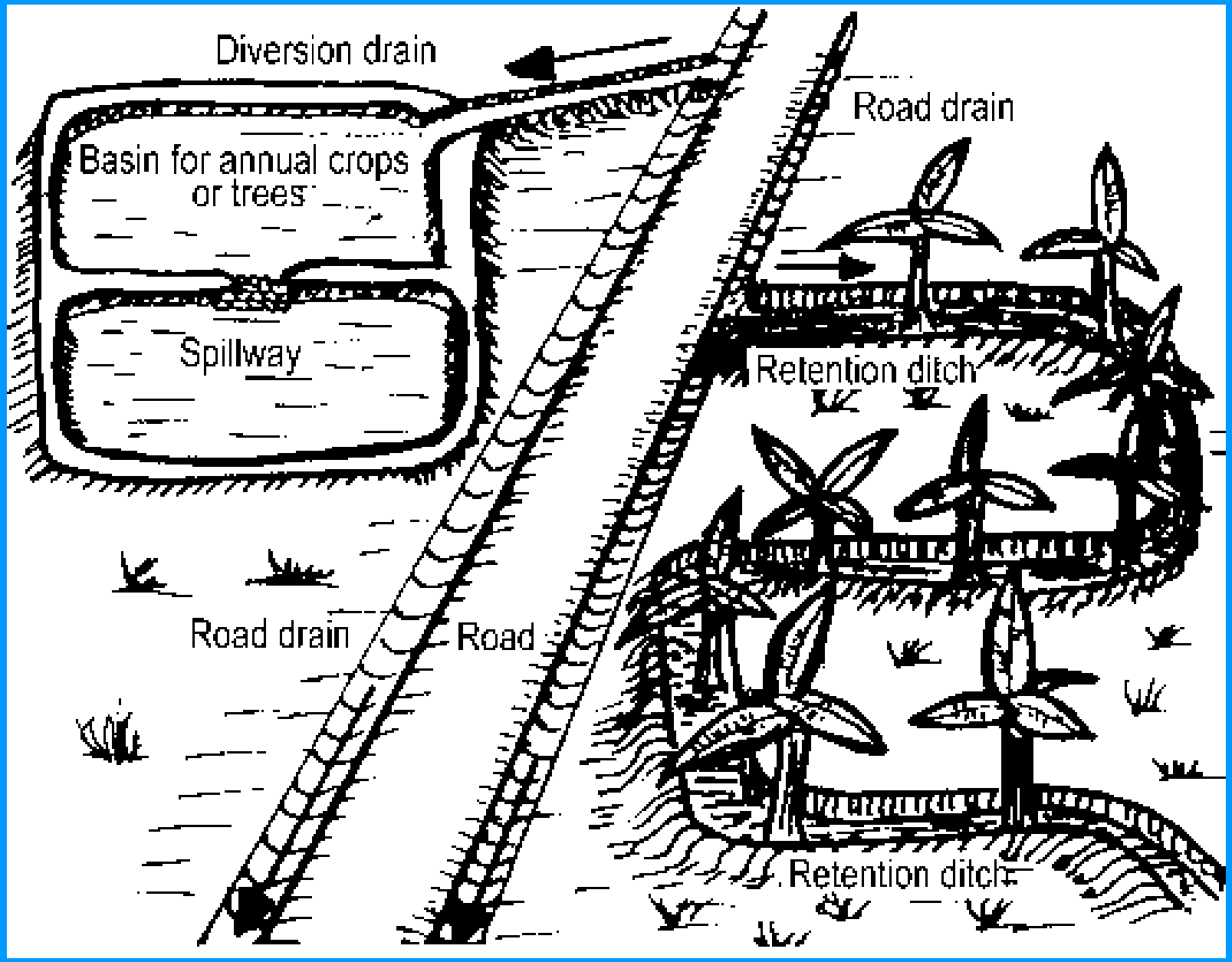
A = RKLSCP

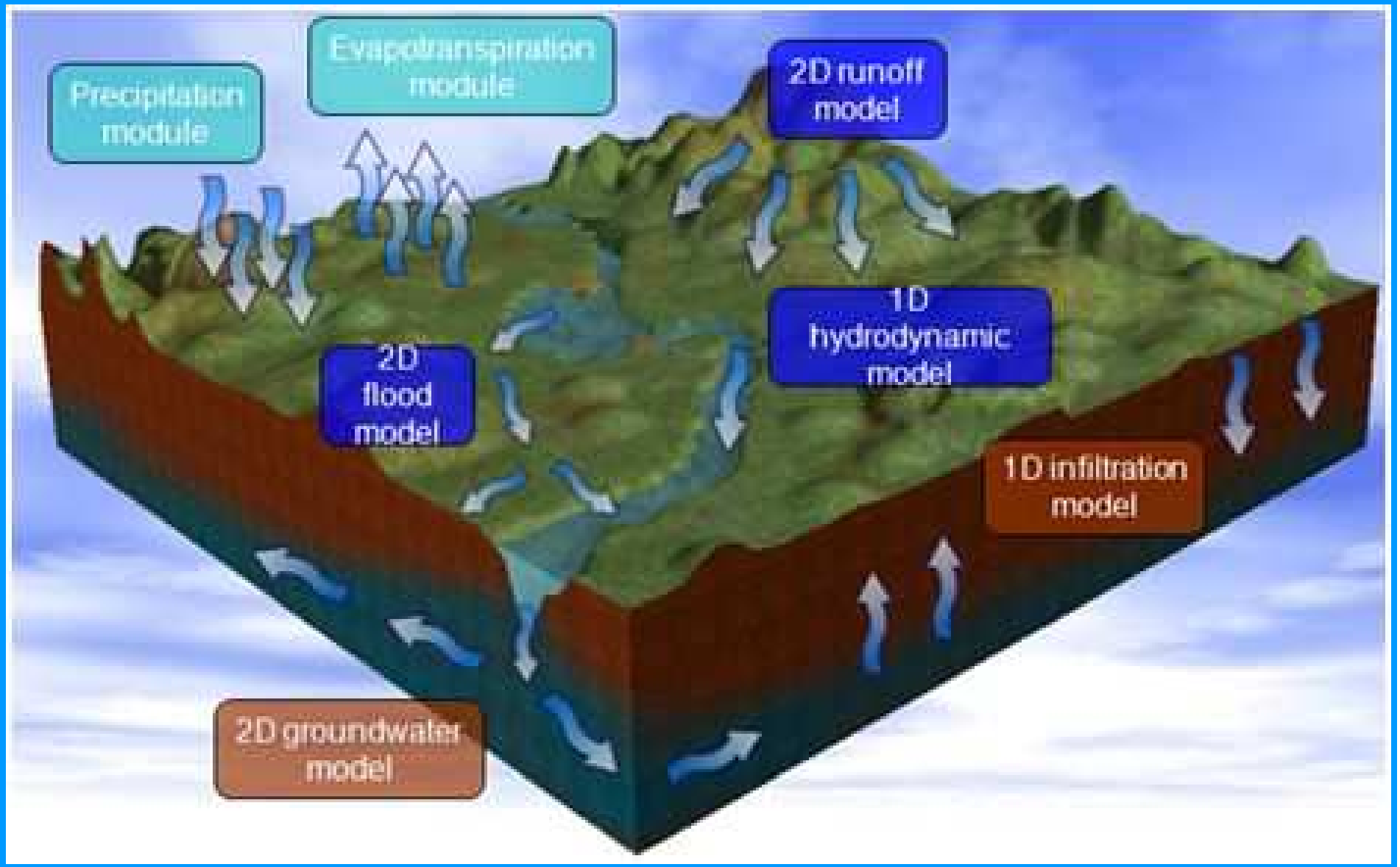


A = predicted soil loss
R = climatic erosivity
K = soil erodibility
L = slope length
S = slope gradient
C = cover & management
P = erosion controls
- *Davis & Nagle*, pg128




HIGH RUNOFF
The observable problem
LACK OF GROUND COVER
STEEP SLOPES
COMPACTED SOILS
BURNING RESIDUES
OVERGRZING
REMOVING RESIDUES
LACK OF FODDER FOR LIVESTOCK IN DRY SEASON
The main cause


Diversion drain
Basin for annual crops or trees
Spillway
Road drain
Road
Road drain
Retention ditch
Retention ditch


Precipitation module
Evapotranspiration module
2D runoff model
1D hydrodynamic model
2D flood model
1D infiltration model
2D groundwater model

In a nut shell

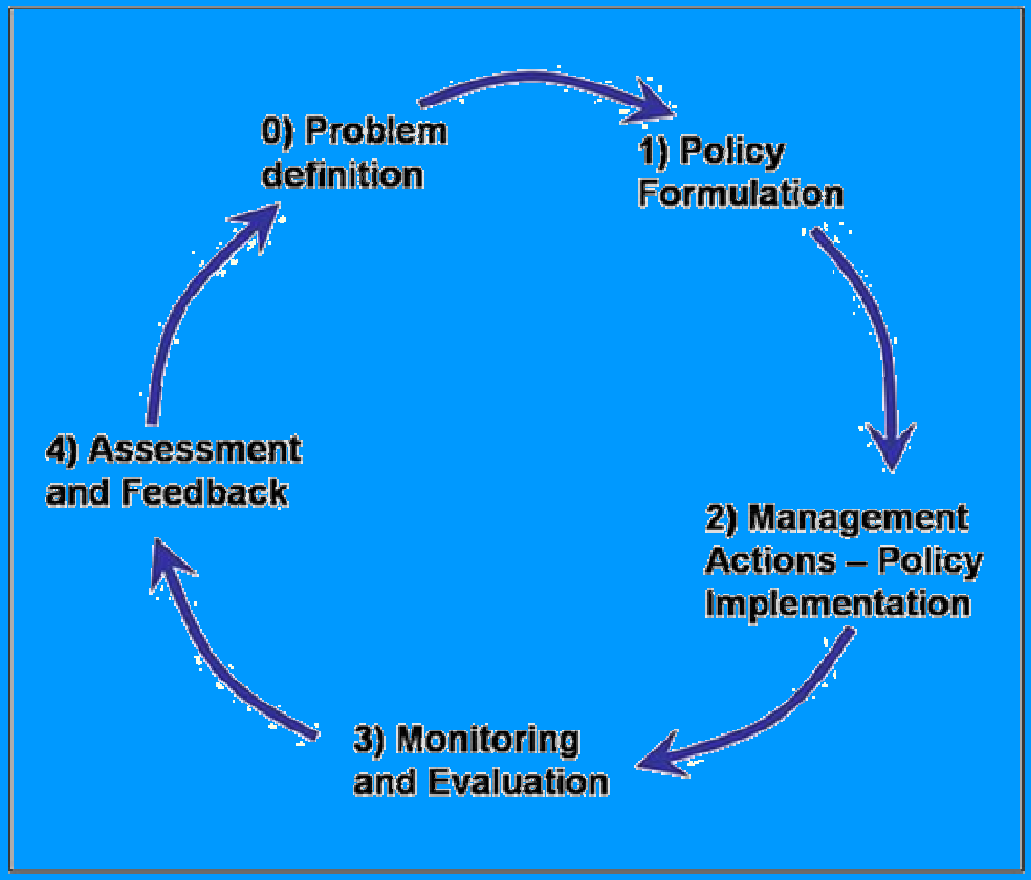
- Identification of risk associated with pollution of water bodies, like lakes, rivers and groundwater.
- Standards development for pollution levels in water and wastewater discharges

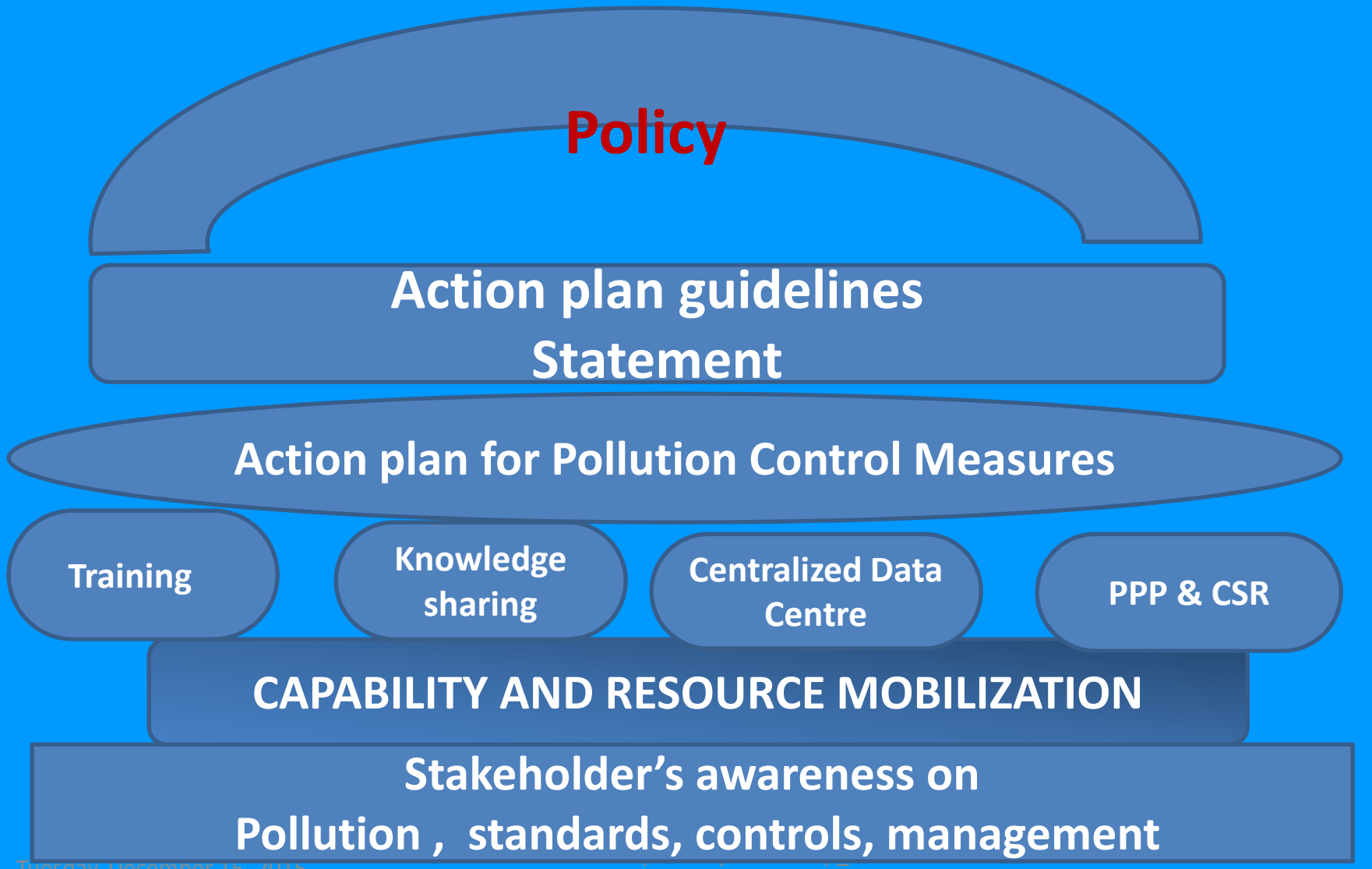
- Development up-to-date technology for pollution monitoring e.g real-online monitoring system, and sensors

- Involvement of various stakeholders in collaborative design efforts

- Abatement technology


What policy?

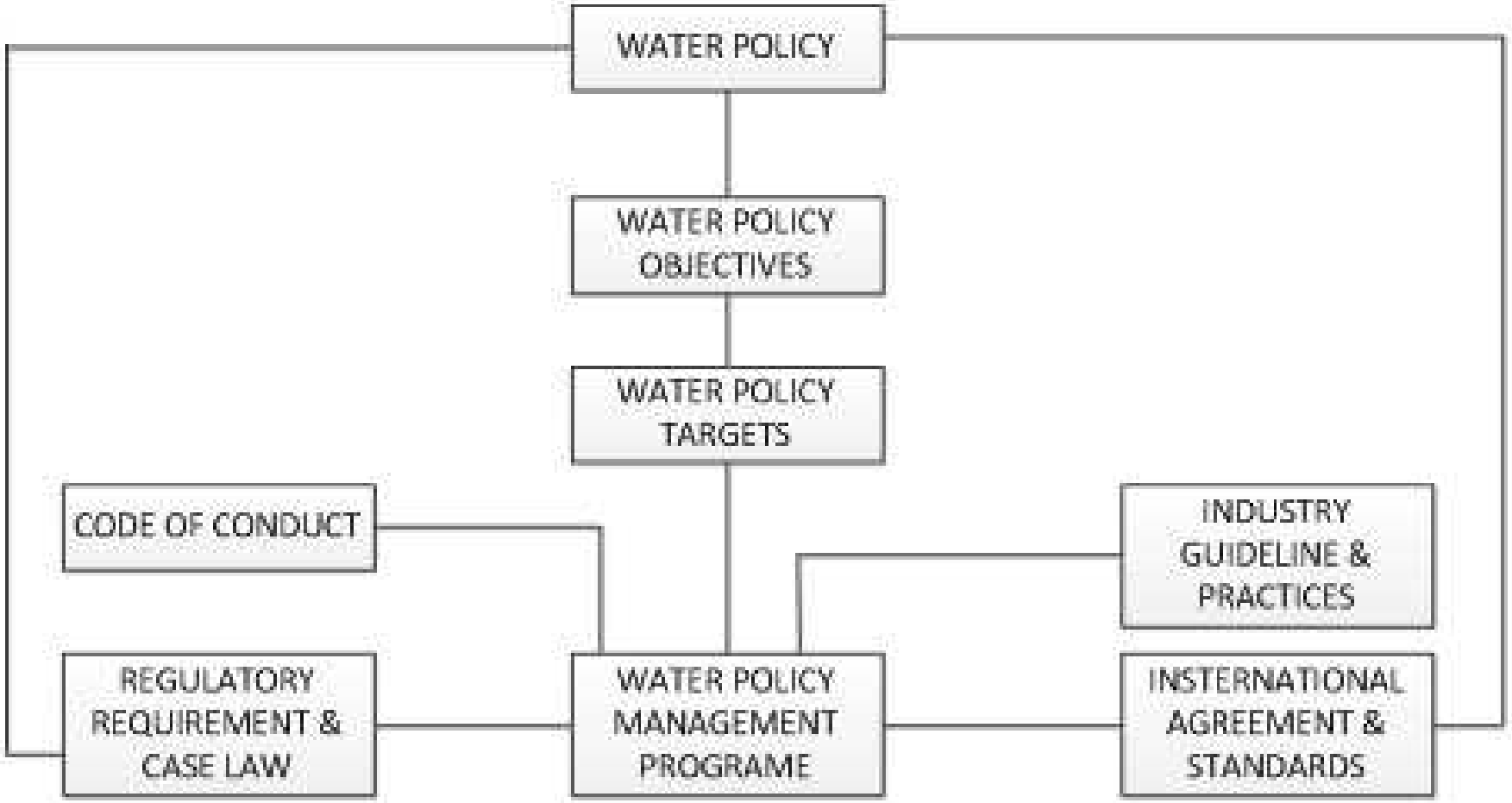

0) Problem definition
1) Policy Formulation
2) Management Actions – Policy Implementation
3) Monitoring and Evaluation
4) Assessment and Feedback


Policy
Action plan guidelines
Statement
Action plan for Pollution Control Measures
Training
Knowledge sharing
Centralized Data Centre
PPP & CSR
CAPABILITY AND RESOURCE MOBILIZATION
Stakeholder's awareness on
Pollution , standards, controls, management

Water Quality & Pollution Prevention

Global Political Objectives

- As defined at Rio+20
  - *significantly reduce water pollution and increase water quality, significantly improve wastewater treatment and water efficiency (para 124 of outcome document)*
  - *reuse of treated wastewater (para 109)*
  - *reducing air, water and chemical pollution leads to positive effects on health (para 141)*
- As defined at Budapest Water Summit
  - *Reduce pollution and increase collection, treatment and re-use of water: Protect human Health and the environment from municipal, agricultural and industrial water pollution, by reducing pollution, collecting and treating wastewaters and maximising their re-use*
- Goal – Target – Indicator – Monitoring - Reporting


WATER POLICY
WATER POLICY OBJECTIVES
WATER POLICY TARGETS
CODE OF CONDUCT
INDUSTRY GUIDELINE & PRACTICES
REGULATORY REQUIREMENT & CASE LAW
WATER POLICY MANAGEMENT PROGRAME
INSTERNATIONAL AGREEMENT & STANDARDS
IMPROVED WATER MANAGEMENT SERVICES

Policy Governing Pollution and Run Off Problems

- Transparency

- International treatise, protocols and agreements
  - Carbon Credit
  - Foreign Direct Investment
  - Cross-boundary issues on pollution and run-off
  - Governmental funding and subsidies

- National policy: zoning off, land-use and land development

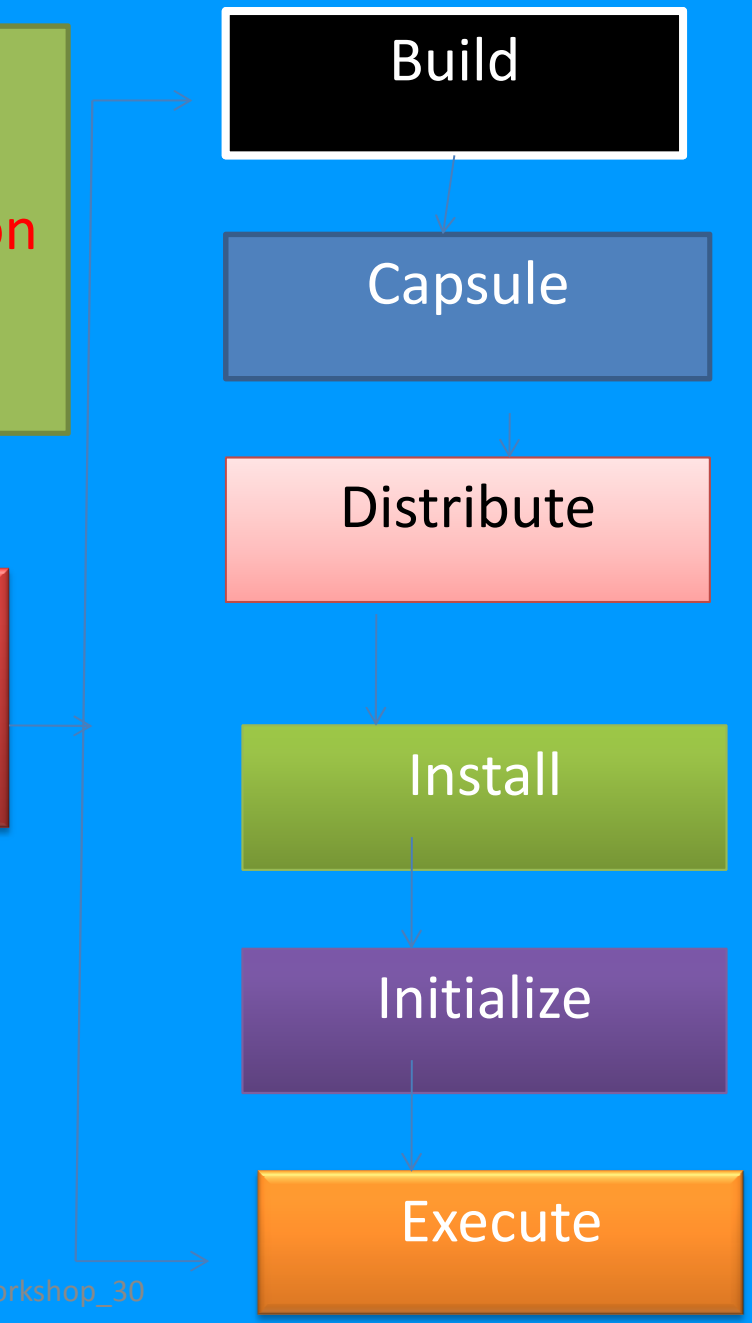
  - Understanding and Assessment of local needs
  - Pricing for pollution
  - Review of Legal framework governing issues of pollution
  - Cooperate Social Responsibility


deploy

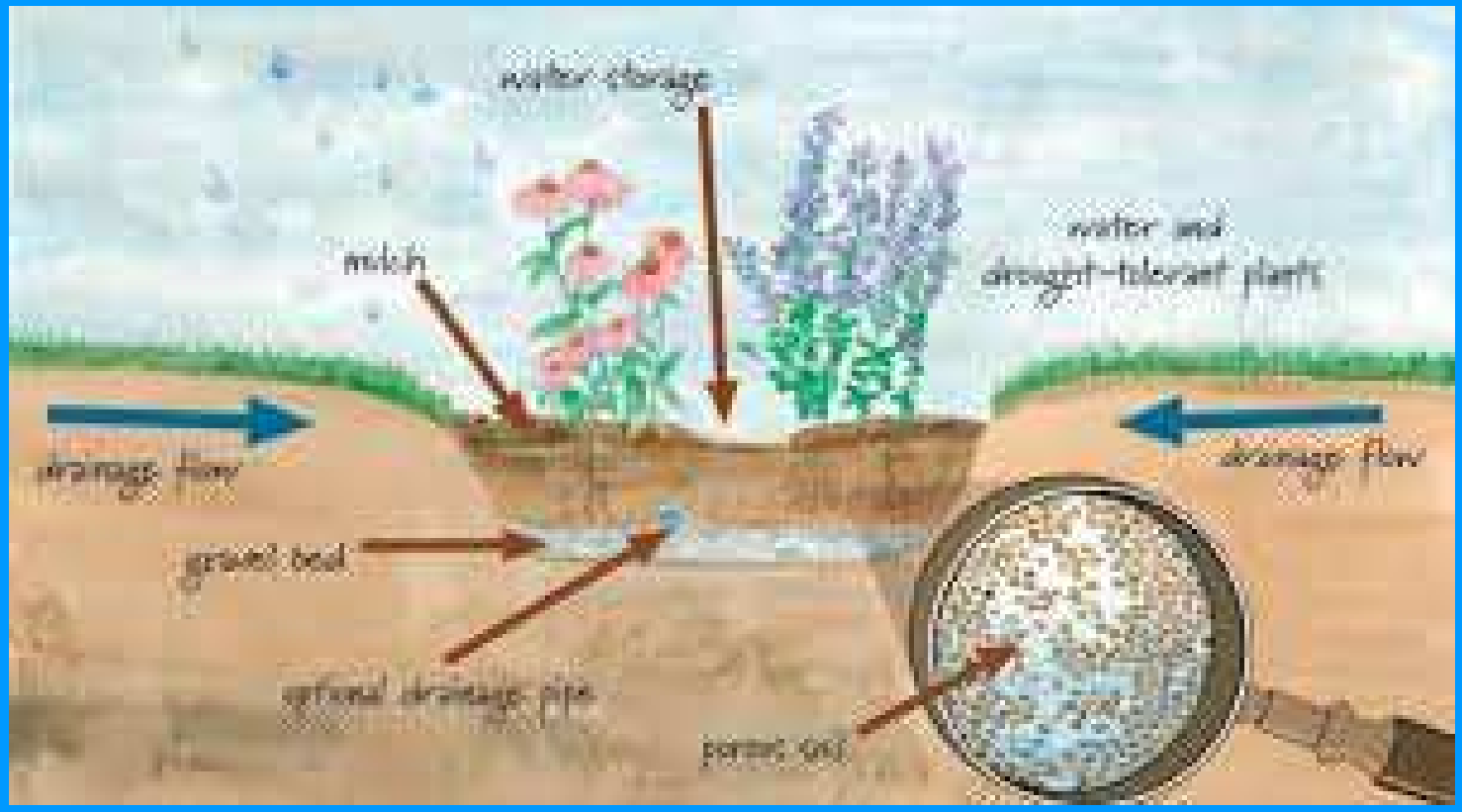
- Enforcement
- Capacity building
- Operation, Monitoring, and Evaluation
- Sensitization and Awareness
- Participatory Approach

A "deployment"

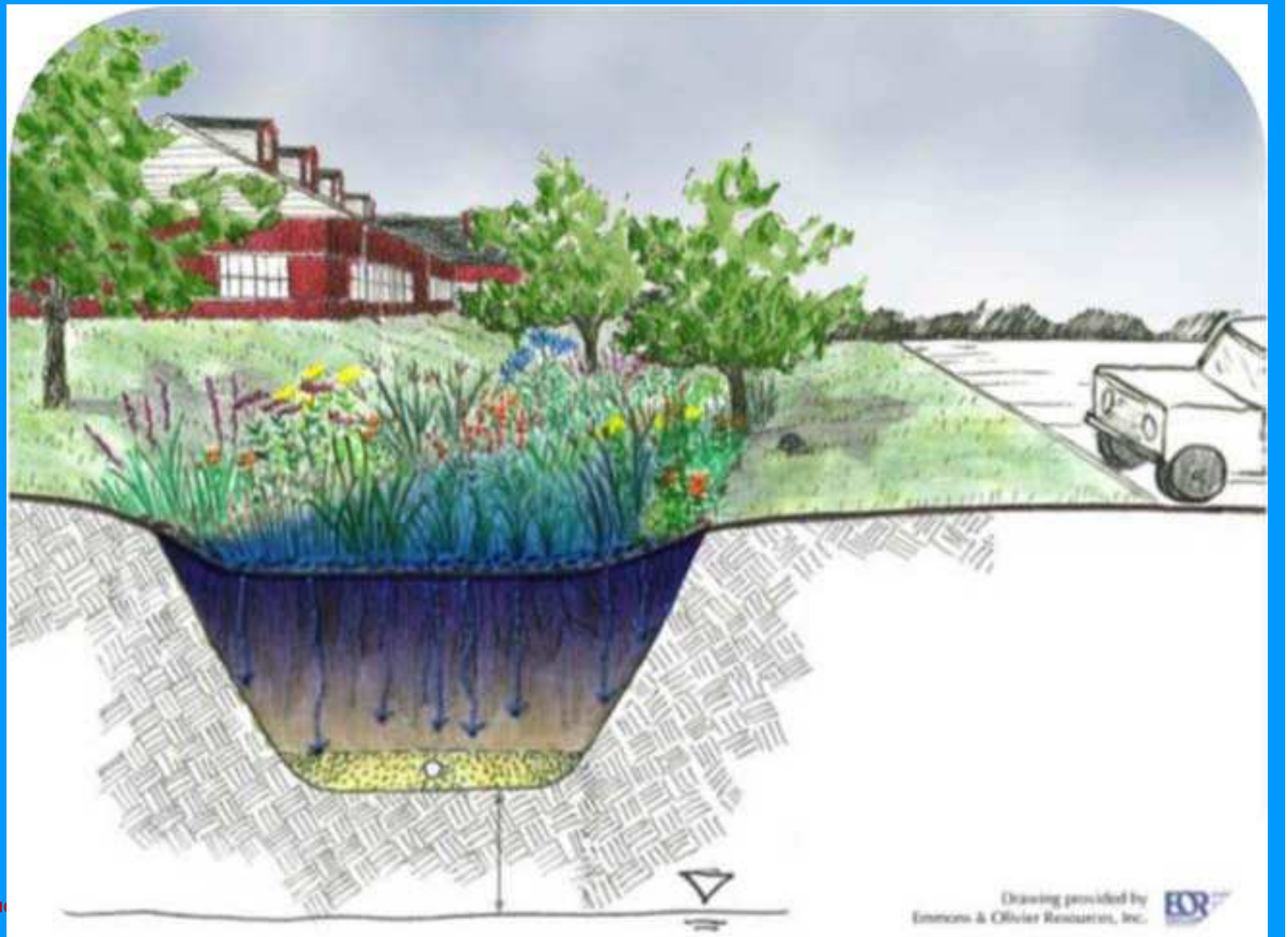
The function stack

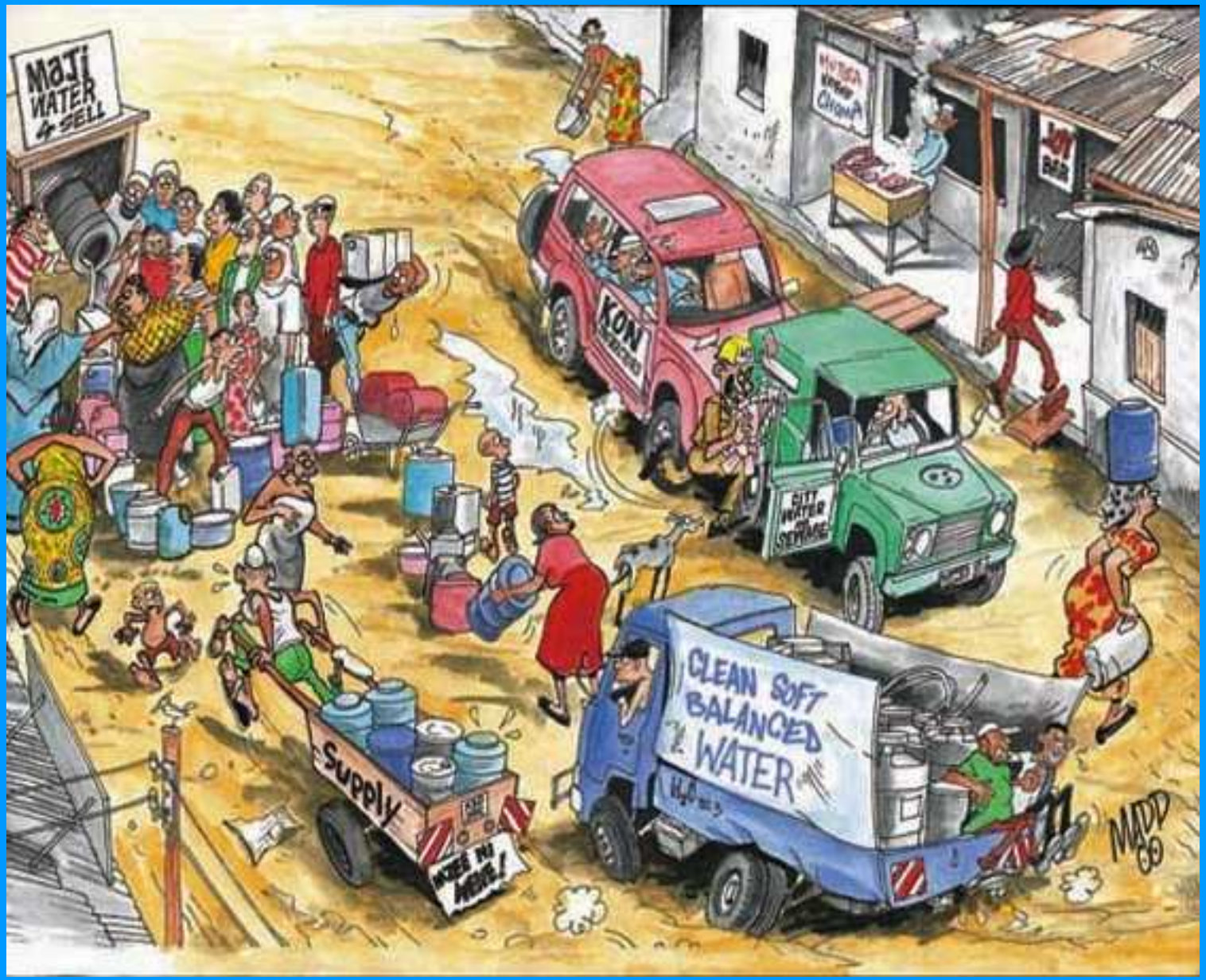


IWRM and its Relations to Sub-sectors

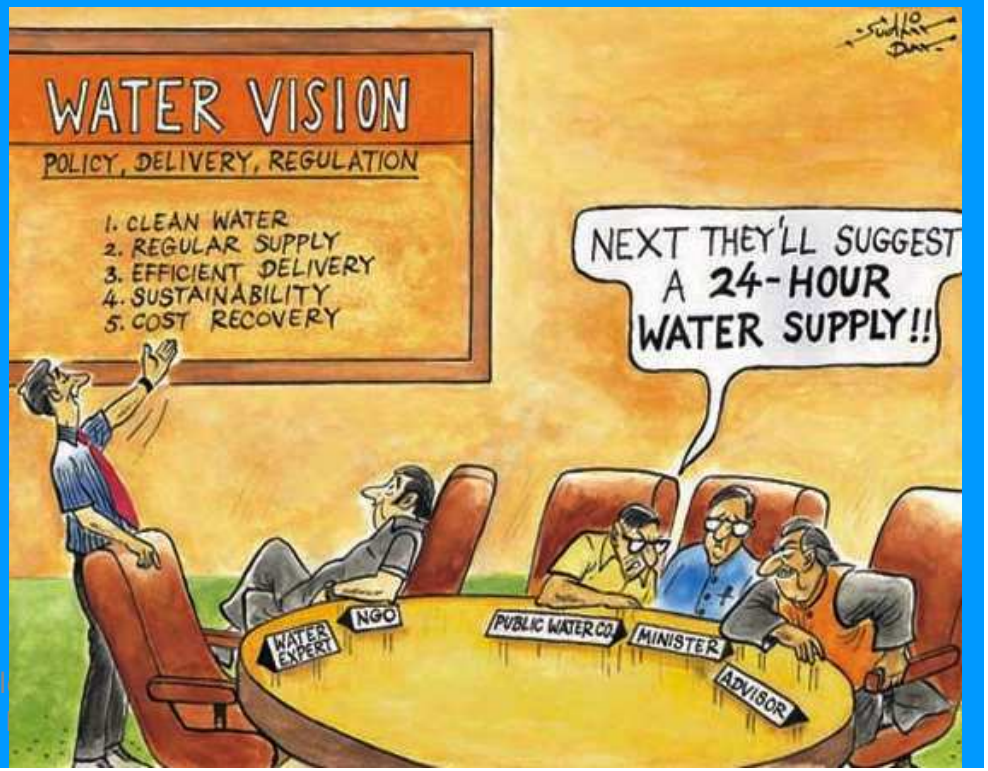

water storage
mulch
water and
drought-tolerant plants
drainage flow
drainage flow
gravel bed
optional drainage pipe
porous soil

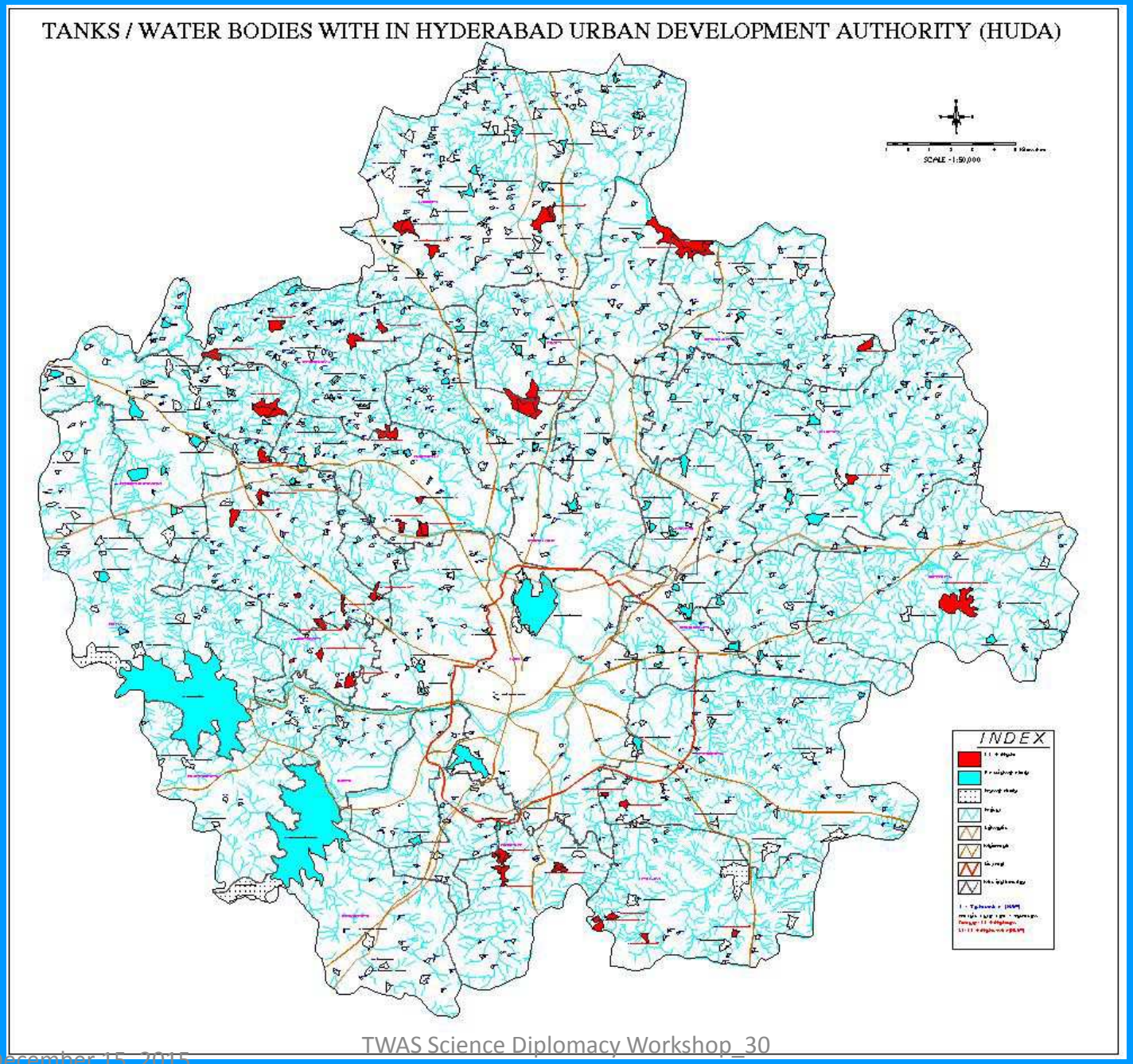
Rainwater Harvesting and Watershed Management


Drawing provided by
Emmons & Olivier Resources, Inc.

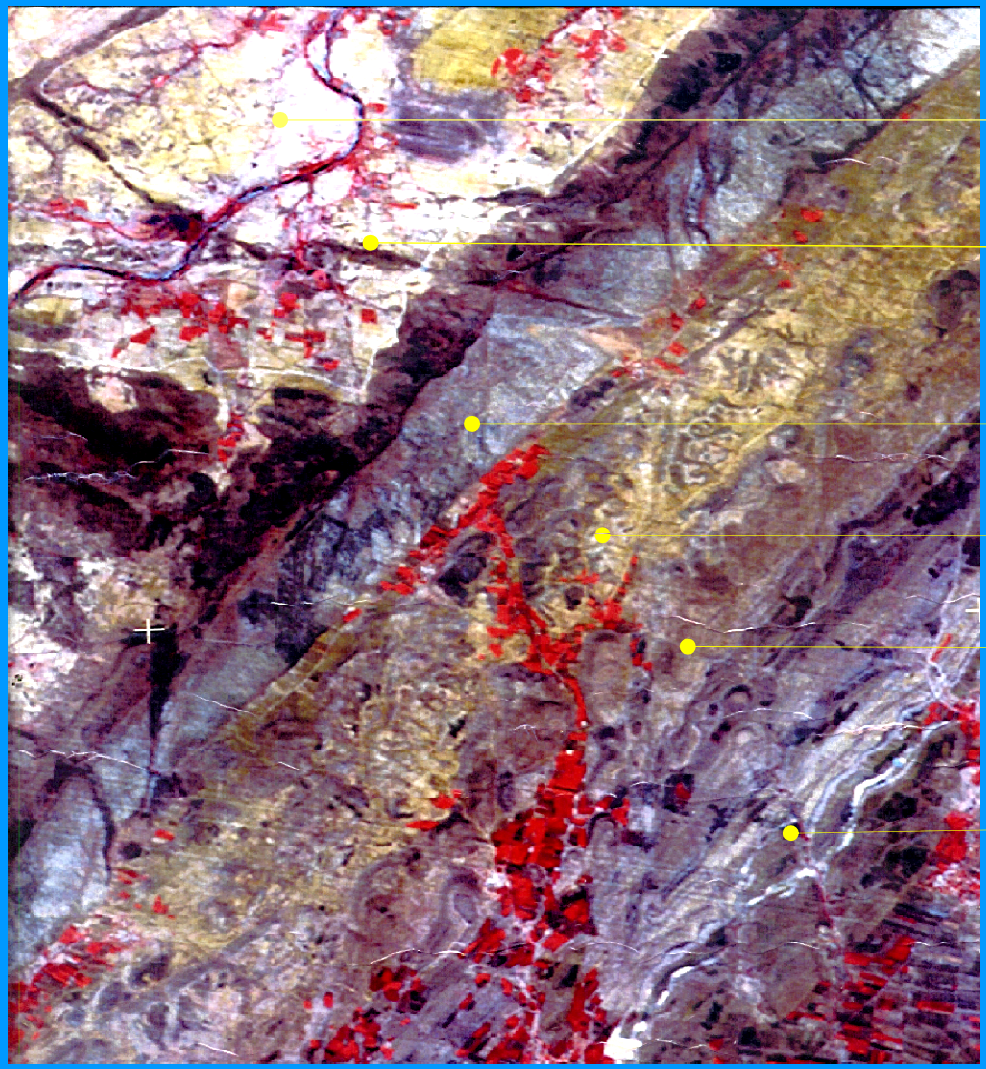

MATI WATER 4 SELL
KON
CLEAN SOFT BALANCED WATER
Supply
MADD


THIS IS GOOD...I'M THIRSTY!
RUNOFF IS WATER THAT FALLS ON LAND AND RENEWS THE FRESH SUPPLY OF WATER.

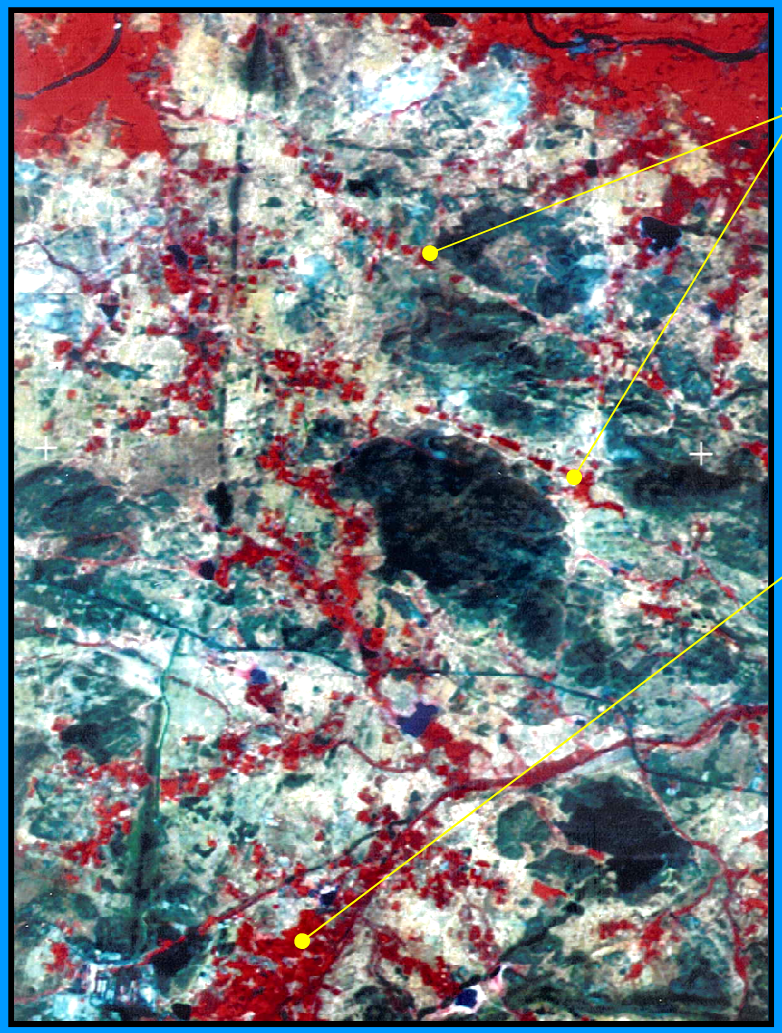

WATER VISION
POLICY, DELIVERY, REGULATION
1. CLEAN WATER
2. REGULAR SUPPLY
3. EFFICIENT DELIVERY
4. SUSTAINABILITY
5. COST RECOVERY
NEXT THEY'LL SUGGEST A 24-HOUR WATER SUPPLY!!
WATER EXPERT
NGO
PUBLIC WATER CO.
MINISTER
ADVISOR


TANKS / WATER BODIES WITH IN HYDERABAD URBAN DEVELOPMENT AUTHORITY (HUDA)
INDEX

Satellite Data in Ground water Studies



Satellite Data in Ground water Studies



Fracture zones in hard rocks-

- **Suitable for high yielding bore wells with greater sustainability**

Ground water irrigated area-

- **Showing over exploited zone**

Emily Jepyegon Chemoiwa, Kenya
Asante

Olusegun Kazeem Abass, China
”xièxie” i

Thatiparthi VL, India
Dhanyavad

Kuan Hui (Elaine) Lin, Taiwan
kám-siā

Derrick Sibusiso Dlamini , South Africa
Dankie

Nothando Dunjana, Zimbabwe
Waita zvako

THANK YOU