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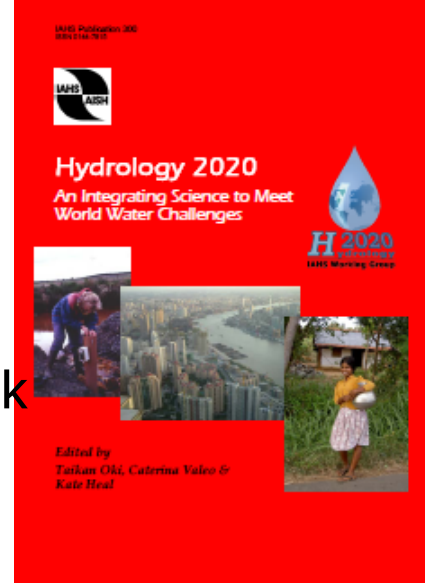
Future outlook of hydrology:

Outcome of IAHS / Hydrology 2020 - PART 2

(2nd H2020 meeting in Paris, France, June 2002)

Hydrology 2020
An Integrating Science to Meet World Water Challenges



1 Introduction

- Uniqueness of hydrology; Aim and scope of book
- Multi-authored Chapters

2 World Water Resources, Water Use and Water Management

3 Hydrology and Water Resources Management for Sustainable Development in the 21st Century

4 Hydrological Measurement

5 Hydrological Simulation Modeling

6 Intersection of Hydrology and Other Disciplines

7 Hydrological Challenges: Scientific, Technological and Organizational Bottlenecks

8 Key Messages, Recommendations and Concluding Remarks

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Contribution of hydrological science to resolve water issues

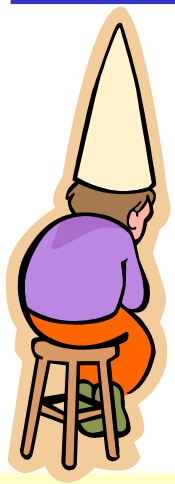
1. Knowledge generation

First class

2. Communicating knowledge to policy makers

Still need to work on this

3. Direct policy adviser or even policy maker



Need to do a lot better

How to increase interaction between hydrologists and policy makers?

- Educate policy makers not to expect solid accurate answers
- Demonstrate gains from policy based on good science
- Understand policy making processes, incl. financial aspects
- Translate scientific results, if possible into action-oriented recommendations for policy makers
- Interact with all relevant organisations
- More effective communication
- Policy maker involvement
- Targets as indicators of progress
- Demonstration sites
- Training and capacity building
- Interdisciplinarity

Hydrology 2020
An Integrating Science to Meet World Water Challenges

The Bottlenecks

A. Scientific Challenges

B. Technology and Infrastructure

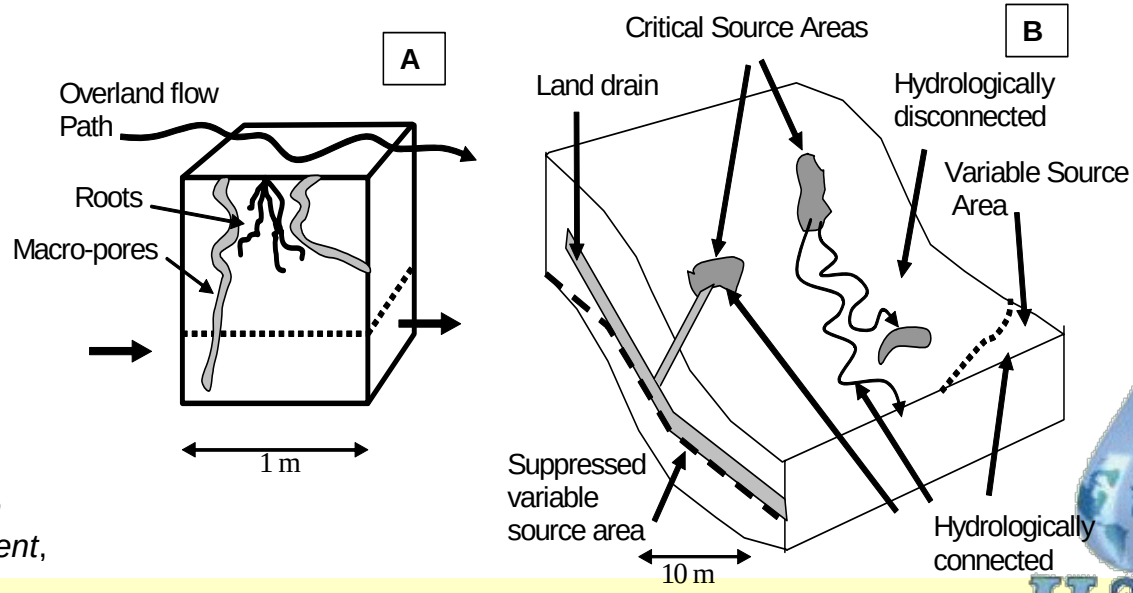
C. Organizational Capacity

A. Scientific Challenges

- Two Key Hydrological Challenges
  1. Hydrological Processes at the Basin Scale
  2. Coupling Hydrological-Ecological-Climate and Human Systems
- Two Cross-Cutting Themes
  1. Modeling and Prediction
  2. Scaling and Integration

Unanswered Fundamental Questions

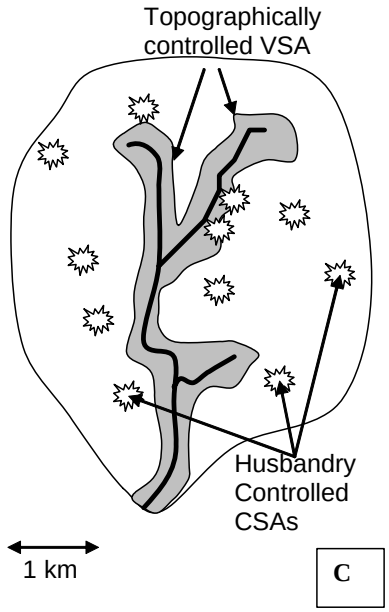
- What are the dominant processes and critical parameters that best capture the dynamics of the system?
- How do these processes and parameters vary between different basins?

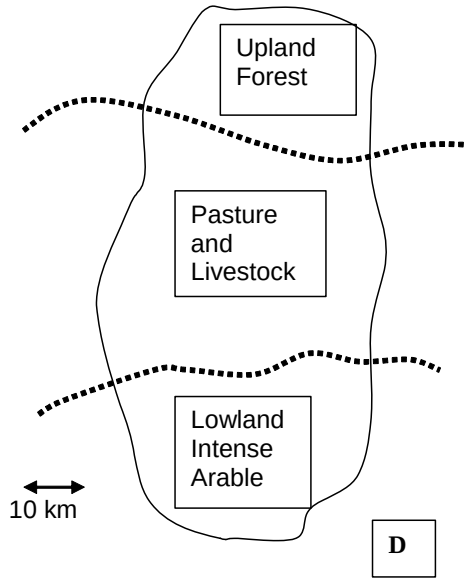


Quinn *et al.* (2004), *Scales in Hydrology and Water Management*, IAHS Publ. 287, pp.17-38

Unanswered Fundamental Questions

- What are the critical space and time scales for measuring hydrological parameters and processes when investigating basins?
- What is the degree of spatial organization within a river basin and how does it impact the water budget?
- How are small-scale insights or measurements appropriate for use within basin models?





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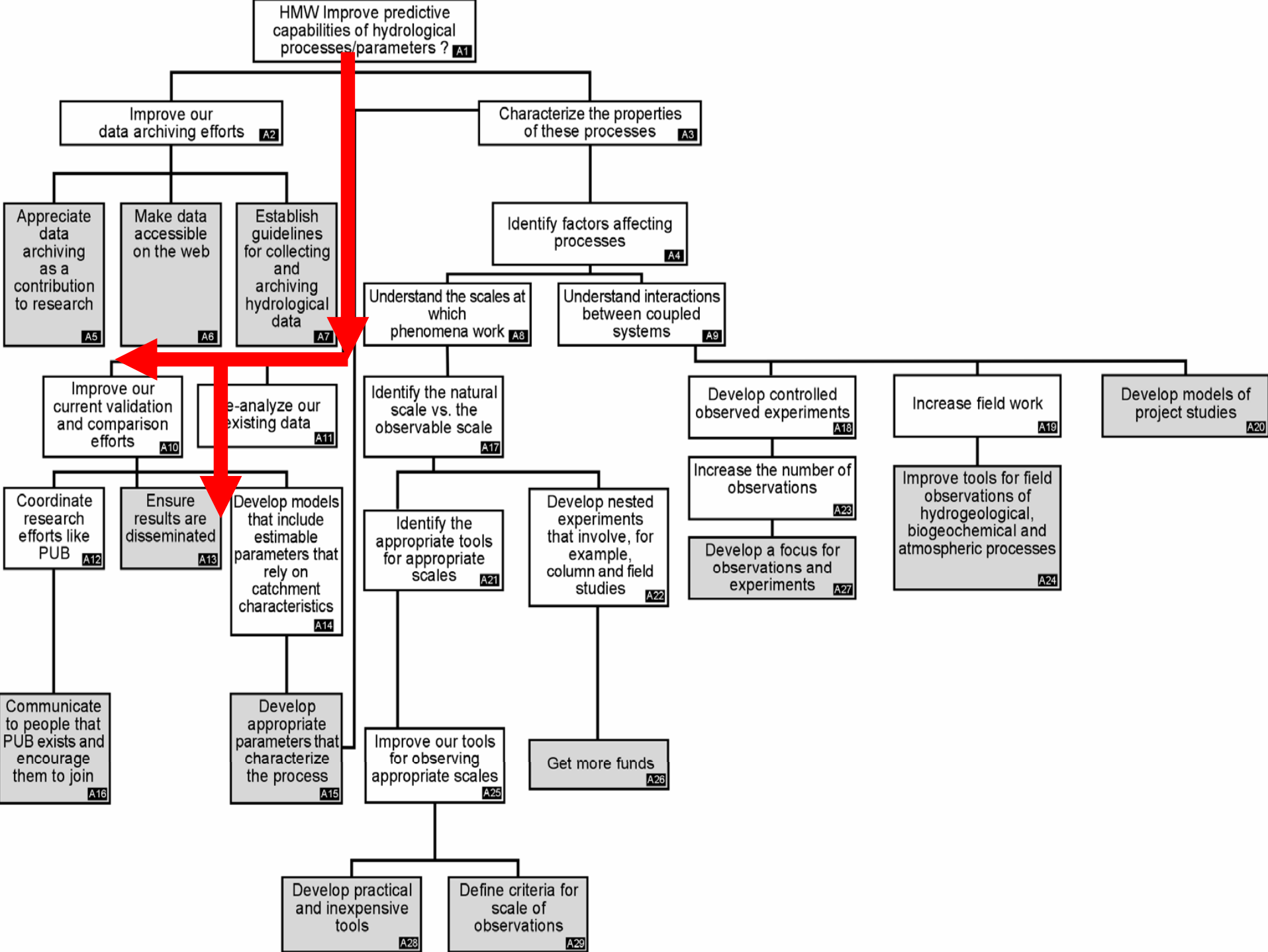
Active Areas of Research

- Reconcile fragmentation across hydrological sub-disciplines, basins, and scales
- Develop new hydrological understanding of basin-scale processes and properties
- Interaction hydrological cycle with other cycles (e.g. carbon); incl. pressures and human impacts
- Integrated theory and modelling, linked to nested scale experiments (laboratory, plot, hillslope, basin and regional)
- Reducing predictive uncertainty through a better understanding of processes and better models -> *PUB!*
- Integration and coupling of models (and data)
- Model application; improved calibration, uncertainty estimation …
- Etc.!

Steps to Overcoming Scientific Bottlenecks in Hydrology?

- ***Barrier analysis trees***


HMW Improve predictive capabilities of hydrological processes/parameters ? A1
Improve our data archiving efforts A2
Characterize the properties of these processes A3
Appreciate data archiving as a contribution to research A5
Make data accessible on the web A6
Establish guidelines for collecting and archiving hydrological data A7
Identify factors affecting processes A4
Understand the scales at which phenomena work A8
Understand interactions between coupled systems A9
Improve our current validation and comparison efforts A10
e-analyze our existing data A11
Identify the natural scale vs. the observable scale A17
Develop controlled observed experiments A18
Increase field work A19
Develop models of project studies A20
Coordinate research efforts like PUB A12
Ensure results are disseminated A13
Develop models that include estimable parameters that rely on catchment characteristics A14
Identify the appropriate tools for appropriate scales A21
Develop nested experiments that involve, for example, column and field studies A22
Increase the number of observations A23
Develop a focus for observations and experiments A27
Improve tools for field observations of hydrogeological, biogeochemical and atmospheric processes A24
Communicate to people that PUB exists and encourage them to join A16
Develop appropriate parameters that characterize the process A15
Improve our tools for observing appropriate scales A25
Get more funds A26
Develop practical and inexpensive tools A28
Define criteria for scale of observations A29

HMW Improve predictive capabilities of hydrological processes/parameters?

Develop practical and inexpensive tools

Define criteria for scale of observations

Develop models of process studies

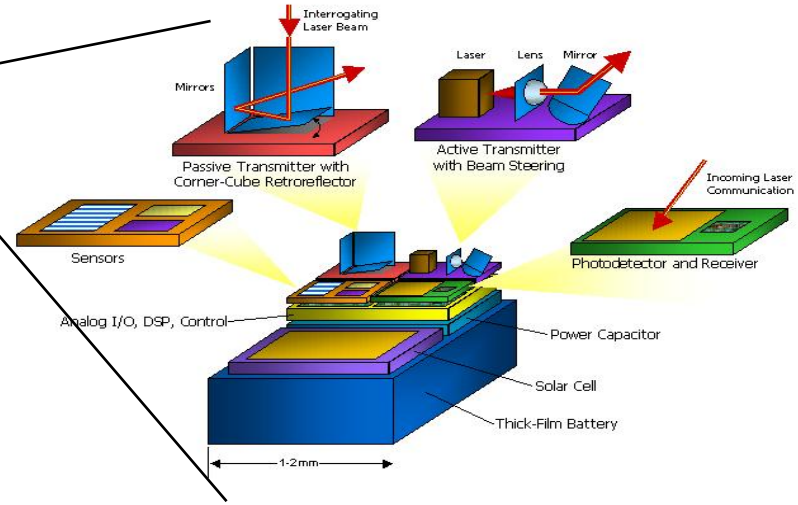
Get more funds

B. Technology and Infrastructure

- Characterization and monitoring data sets and tools
  - Elucidate the states, stocks, fluxes and residence times in all domains
- Two Key Challenges
  - Measurement and sampling approaches
  - Data access and database issues

I: Measurement and Sampling Approaches

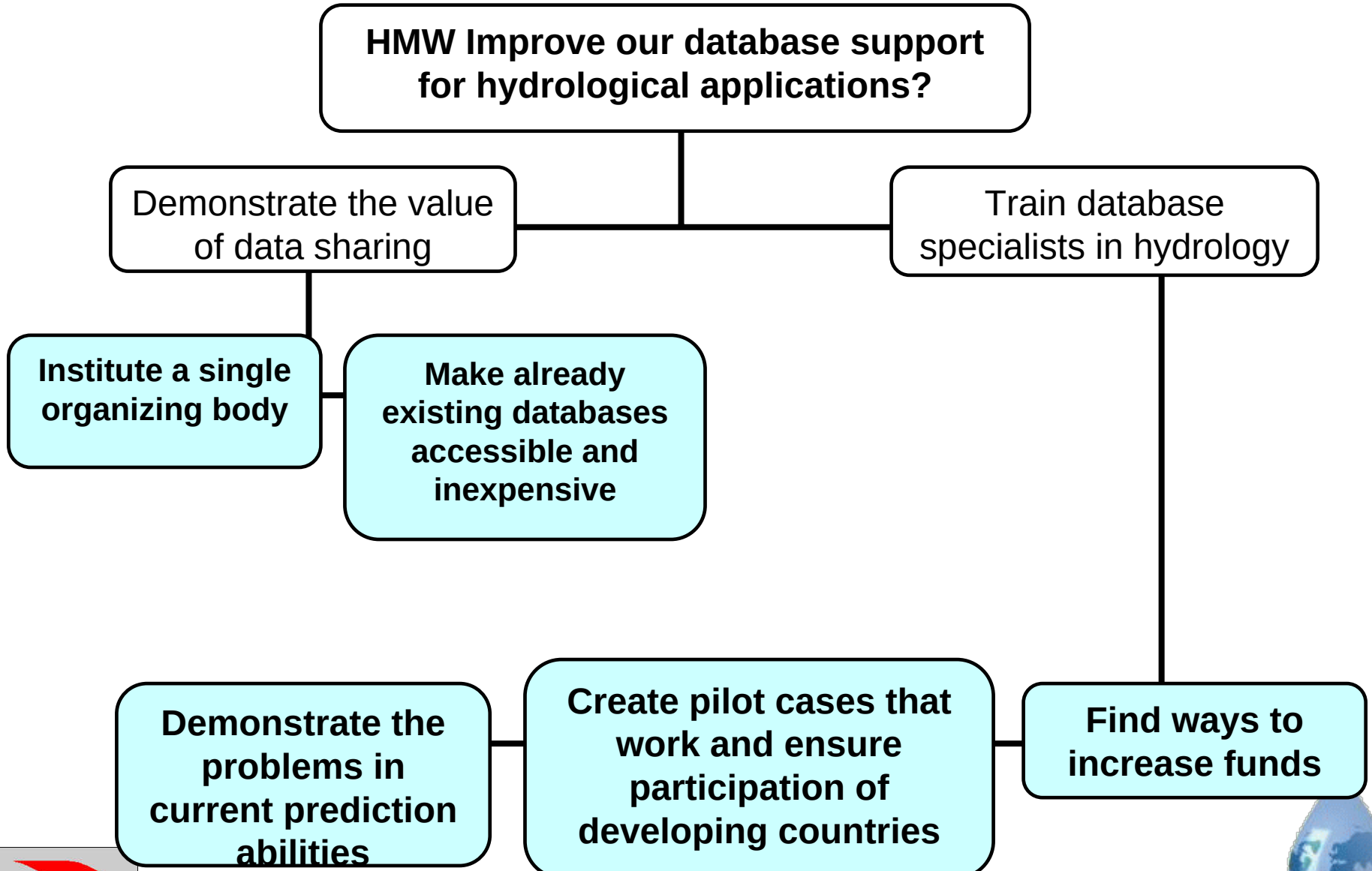
- Data collection over various spatial and temporal scales
- Enhance resolution and increased accuracy
- Collect over long periods of time
- Strategic sampling strategies
- Incorporate “unconventional” measurements



- Hydro-geophysical data
- remote sensing data
- geochemical/isotopic tracer data
- ‘intelligent’ micro sensors offer great potential

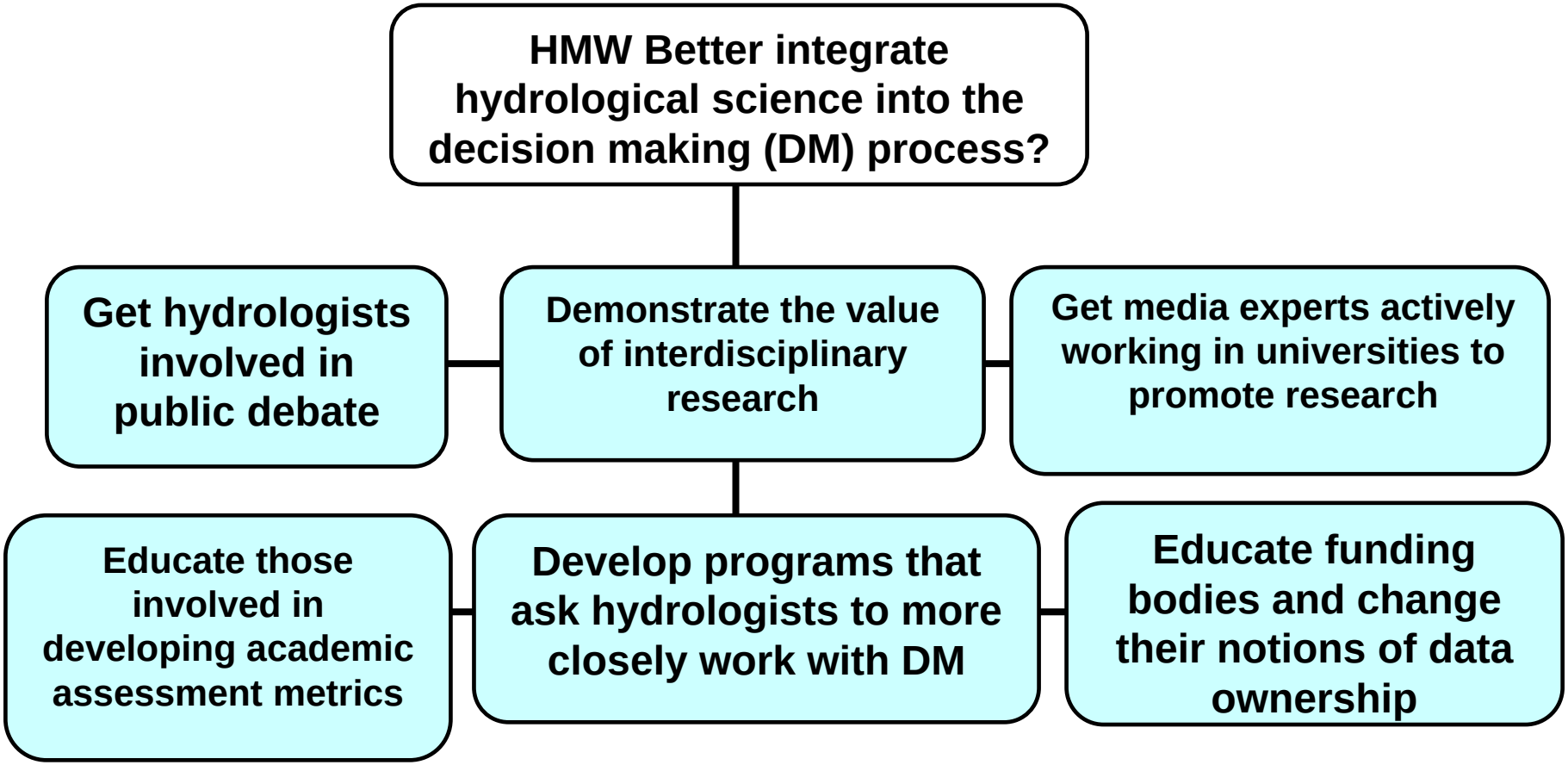
II: Data Access and Database Issues

- Free access to hydrological data
- A worldwide water resources database
  - collect, structure, archive, and disseminate via web services
  - Data over long enough timeframes to document hydrological extremes (~50–100 years)
- Currently fragmented over space - time, variable content structure:
  - National Water Information System, WMO, NASA, US EPA, NOAA, Atmospheric Radiation Measurement programme, Unidata, Global Runoff Data Center (at BfG Germany), …


HMW Improve our database support for hydrological applications?
Demonstrate the value of data sharing
Train database specialists in hydrology
Institute a single organizing body
Make already existing databases accessible and inexpensive
Demonstrate the problems in current prediction abilities
Create pilot cases that work and ensure participation of developing countries
Find ways to increase funds

C. Organizational Capacity

- Policy and decision making for effective sustainable water resources management
  - Strike compromises among competing water uses
  - Develop sustainable water resource plans
  - Alleviate and mitigate pollution
- These policies must be driven by scientific knowledge and scientifically based recommendations, which stem from appropriately directed hydrological research and adequate funding



NEED: A single overlying body that can help in directing and coordinating research projects, ensure integration between research and practice, increase data accessibility, educate and involve the public, and find ways to increase funds

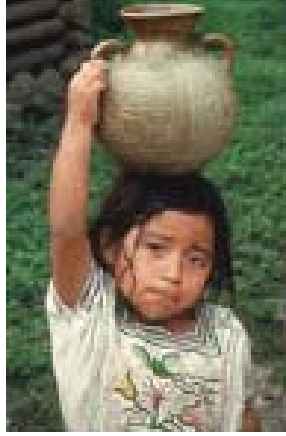
Global Hydrological Intergovernmental Organising Mechanism (GHIOM) for Hydrological Science and Water Resources

- *With substantial funds and commitment the GHIOM would be a crucial contribution to sustainable water resources management!*

- *NOT a single new UN agency!*

GHIOM

Coordinated Research Management and Policy



- Develop, fund and coordinate long-term research programmes and ensure that they are linked to policy development and implementation
- Identify key hydrological research priorities
- Coordinate and contribute to water policy activities at different scales
- Central spokes-organization for hydrology and water management worldwide

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Testing Centres

- Centres/areas
  - test models and approaches
  - share data/instrumentation
  - train students, i.e. from developing countries
- Centres should work together to establish data standards, formats and calibration approaches and to coordinate long-term data acquisition, archiving, and digital dissemination

Public Awareness, Education and Outreach Efforts

- Appreciation of the value of freshwater to society
- Advocate public education in hydrology (primary school onwards …)
- Engage young and bright scientists, and make formal connections between the many interacting sub-disciplines
- Establish and maintain regional hydrological training centres
- *…. learn from atmospheric scientists!*

GHIOM

Technology Transfer and Capacity Building

- Balance between supporting fundamental research and finding practical solutions to water management problems
  - Developing countries
- Support and guidance for training hydrologists and water managers

Main Messages

- Recognize hydrology as the integrator
- Lack of understanding of hydrological processes at catchment scale, and coupling of processes and models
- Often fragmented nature of hydrological expertise: Community consensus on what the hydrological challenges are (*-> prioritize and long-term commitment needed!*)
- Promote a global hydrological intergovernmental organizing mechanism (GHIOM)
- Transfer knowledge to policy and decision makes
- Involve young scientists in hydrological research

- *The further development of hydrological science should be seen as a critical investment opportunity for global welfare!*

Acknowledgements

- John Rodda, Kuni Takeuchi, Arthur Askew, Zbigniew W. Kundzewicz and Pierre Hubert of IAHS
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- German IHP
- Many more ...

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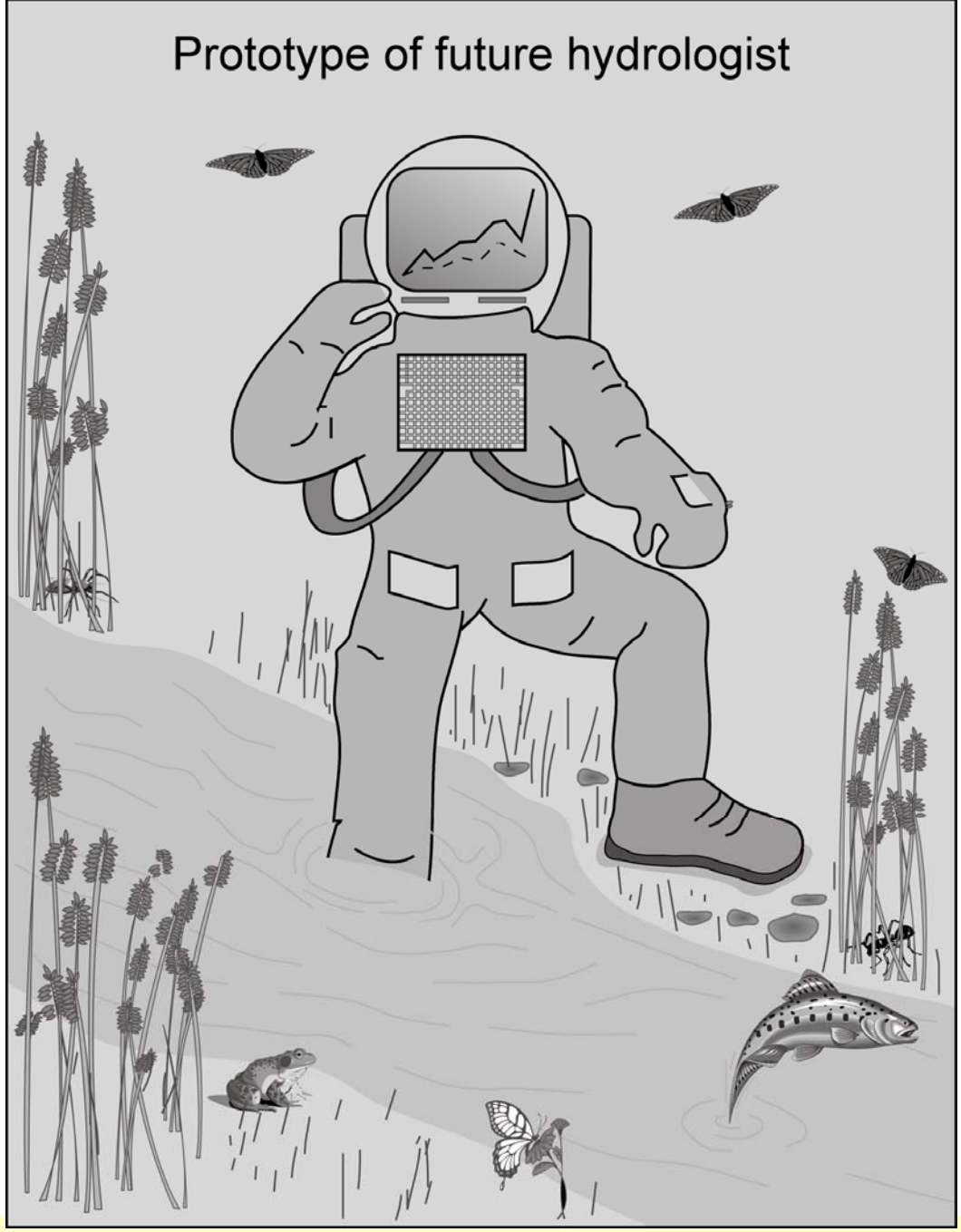

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GHIOM
Taking it forward

- We urge the hydrological sciences and water policy communities to support the promotion of a global hydrological intergovernmental organizing mechanism (GHIOM) that would serve as the authoritative scientific and educational voice of hydrology and organize coherent research efforts toward resolving water related problems.

Global Coordination Mechanism

ISSUES

- Unsuccessful attempts in the past
  - Protectionism among existing organizations
  - Lack of willingness to support additional intergovernmental organizations among national funding agencies.
  - Water issues considered as part of national security
- Current situation: lack of coordination and the duplication of efforts
- We urge the hydrological sciences and water policy communities to support the strengthening of global hydrological intergovernmental coordinating mechanism that would serve as the authoritative scientific and educational voice of hydrology and organize coherent research efforts toward resolving water related problems.

An interdisciplinary future for hydrology?

- Barriers
  - Multidisciplinary -> interdisciplinary
  - Funding patterns
  - Lack of communication
  - Concern about “second rate” science

  “*The generalist knows nothing about everything and the specialist knows everything about nothing*” (Hillel, 1991)
- How to overcome these barriers
  - Train scientists in cooperation skills
  - Recognise benefits of interdisciplinary research
  - Funding for networks and communication