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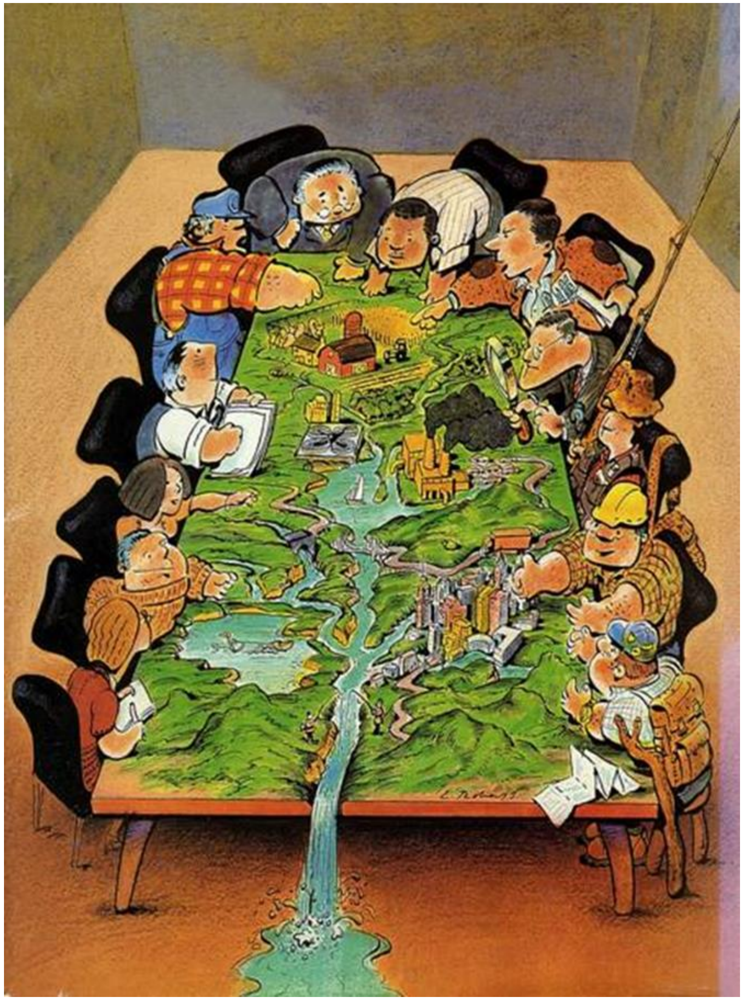
Water Resources Management –

Challenges … and the use of models



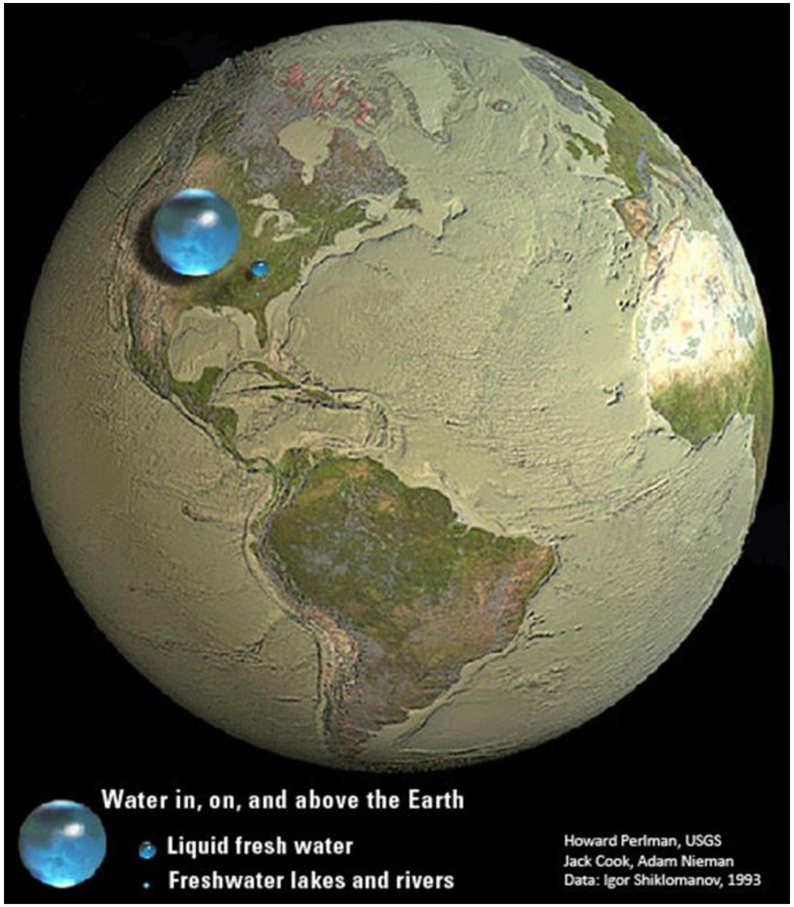
Kees Bons
Team leader

Strategic Basin Planning for Ganga River Basin in India

Content

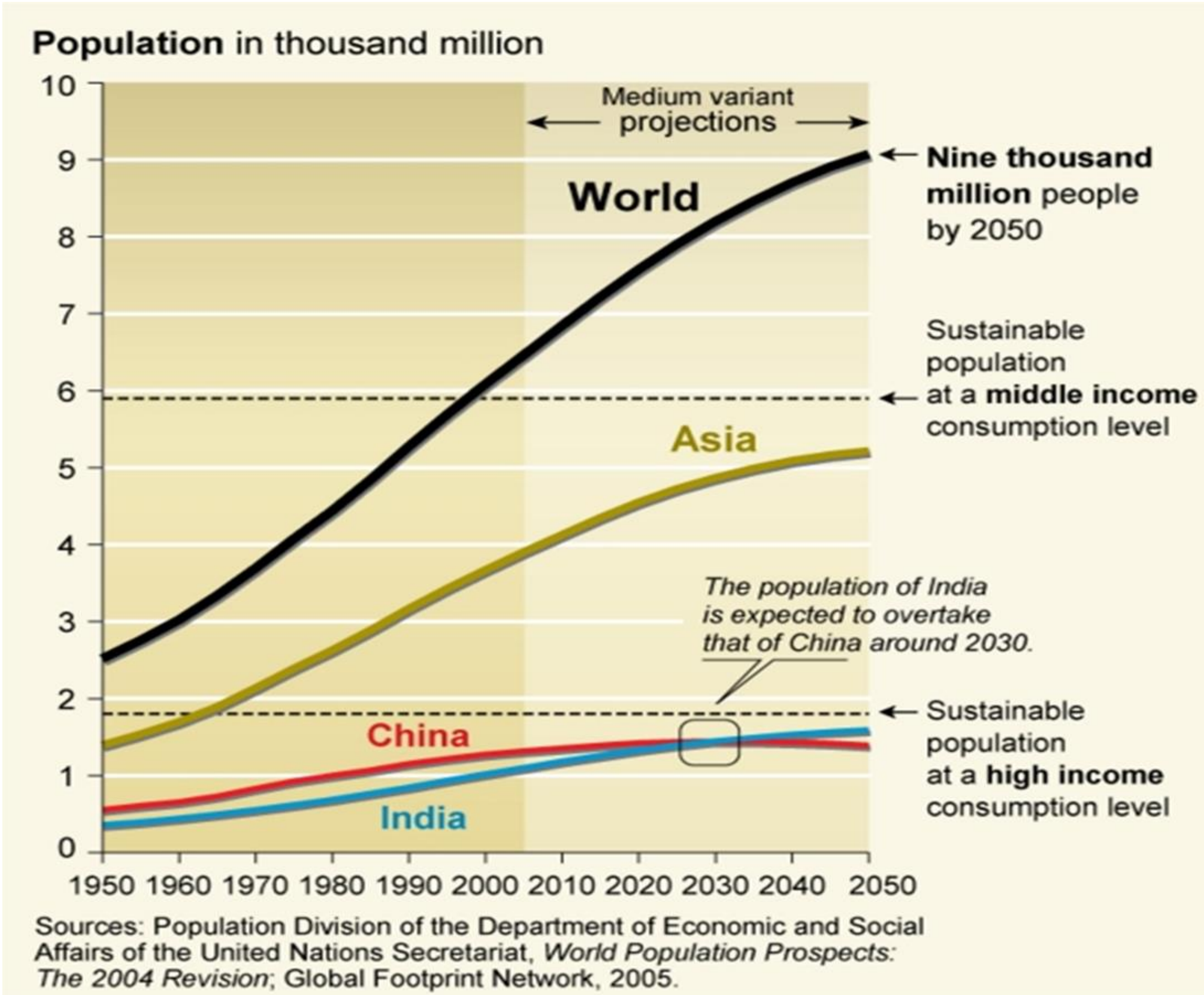
1. A changing world – implications for water management
2. Integrated Water Resources Management
3. Why use of models in IWRM
4. Example of Yellow River, China

1. Our fresh water – drivers for change

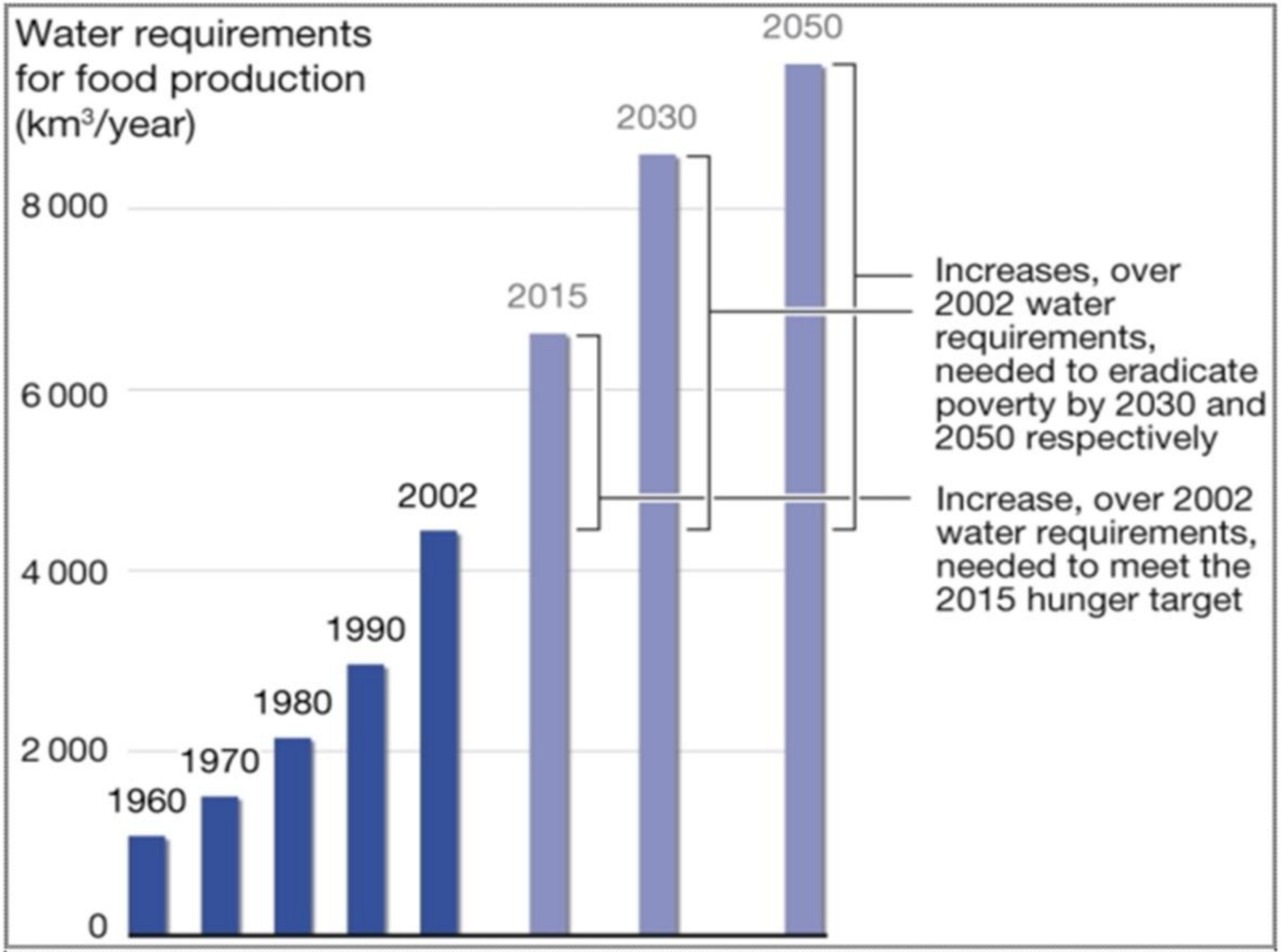


- Energy, Food, Water Demands
  - increasing
- Supplies
  - more variable and extreme
- Water
  - more contaminated
- Environment, Ecosystems
  - more concern
- Future uncertainties
  - increasing
- Why
  - climate? **PEOPLE** ?

A more populous world



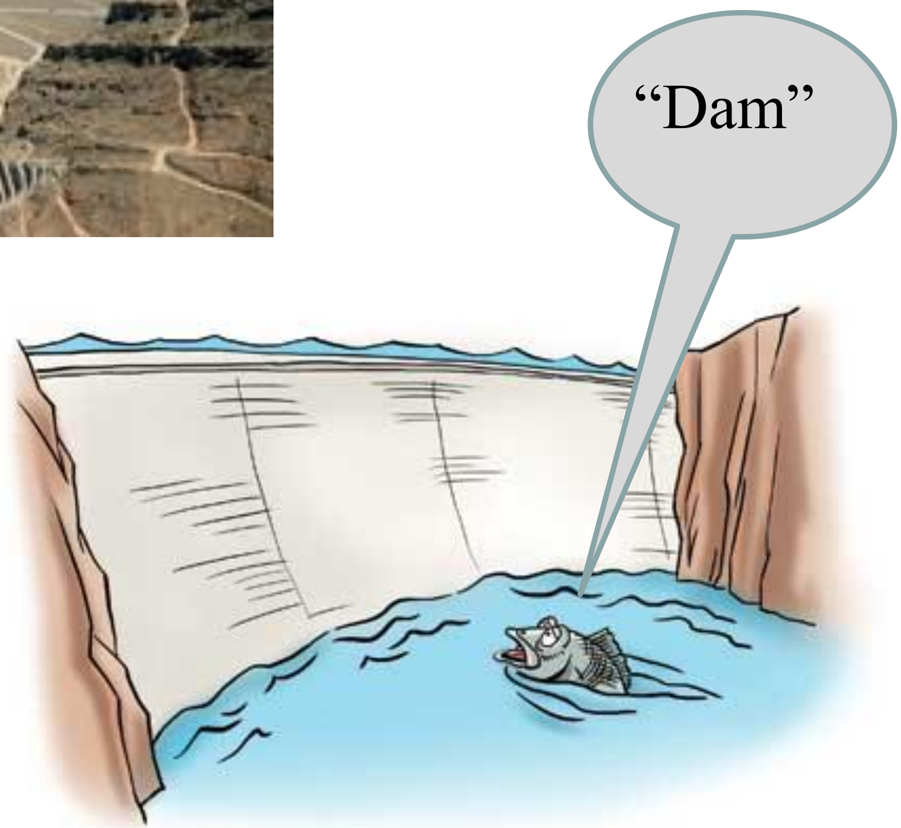
A hungrier world 1960 - 2050



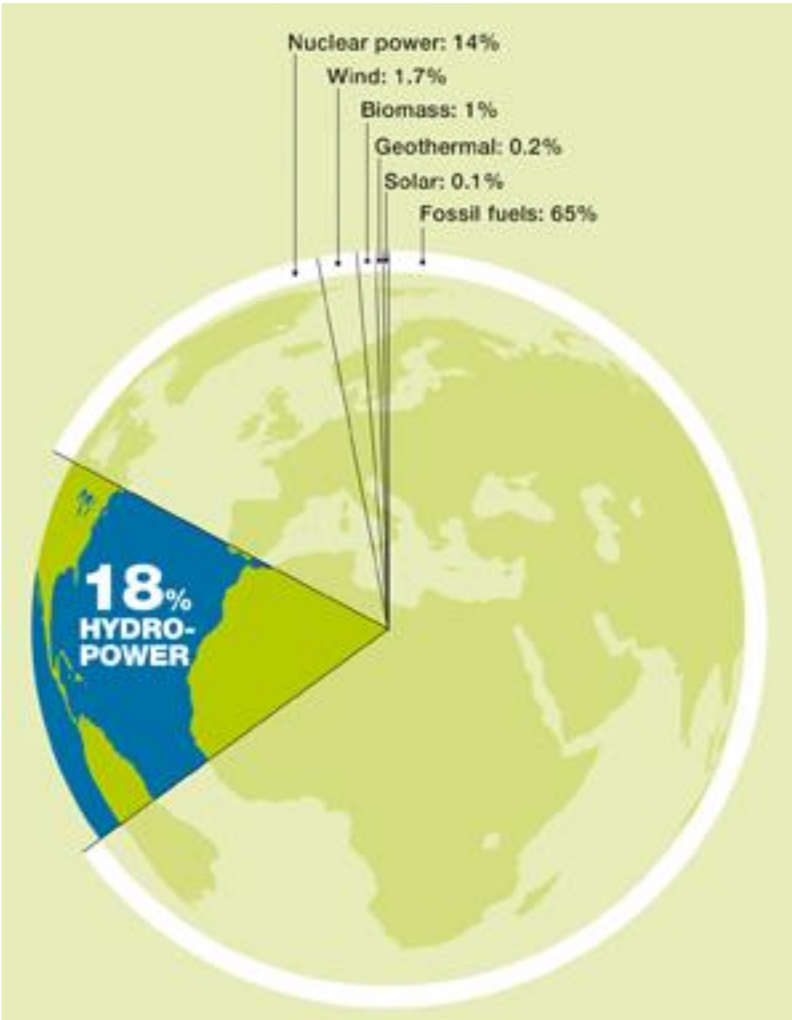
Demand for more…..

…….or less

dams



Demand for more hydropower



A more prosperous world

changes in life styles

Each 150 g. hamburger requires 2400 liters of water.

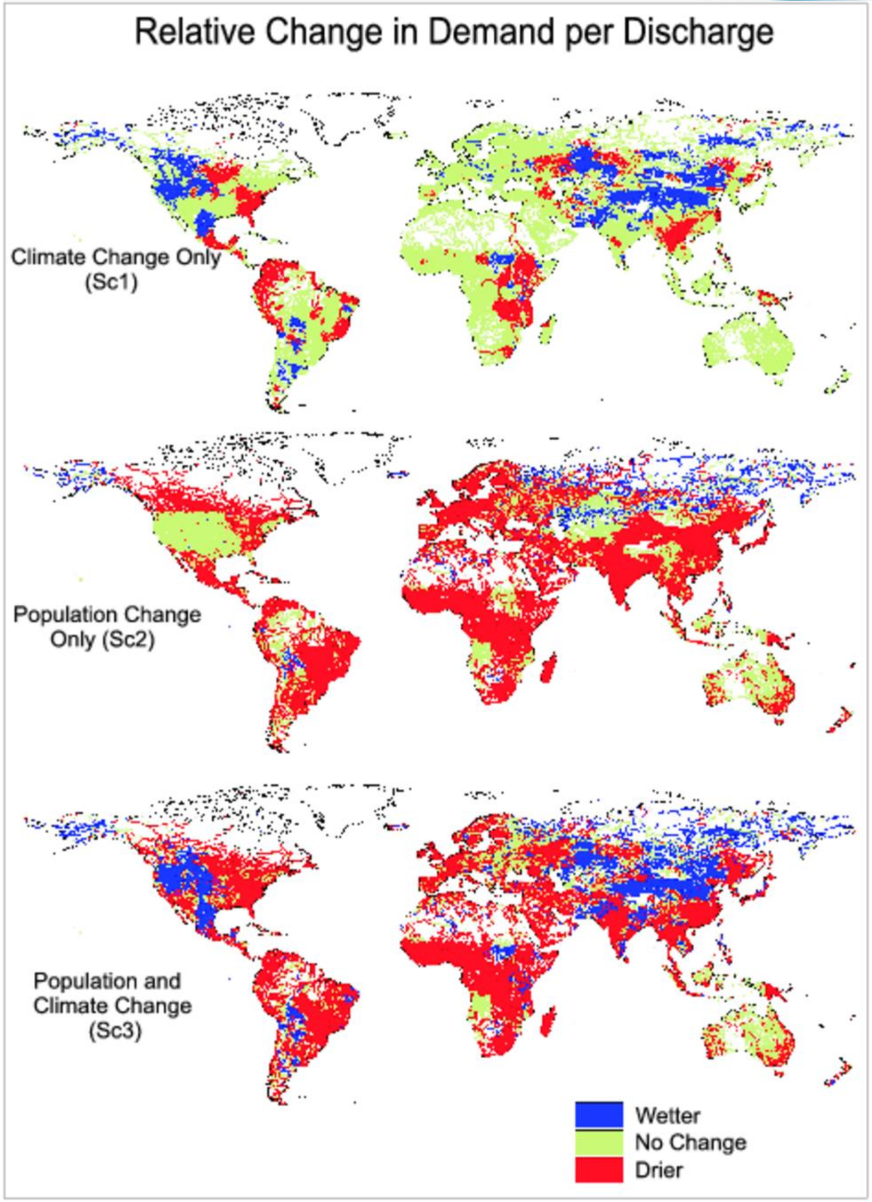
As people become wealthier their diets change.

They consume more meat and dairy products.

They take more energy and water to produce than vegetable diets.

Prosperous people use more energy to maintain their lifestyle.

Water Stress Changes to 2025



- **80% of future stress from population & development, <u>not</u> climate change!**
- **Correct Priorities? (E.g. 85% US global change research funding goes to climate and carbon)**

So …

- Our changing world forces us to take action
  - we have improve our water management
- Water has become a scarce resource
  - easy solutions are not available anymore
  - developing the system for one user might harm another (downstream) user
- It is not just a technical and economic challenge anymore
  - strong social and environmental dimensions
  - transboundary issues
  - politics and governance issues dominate
  - etc
- Need for Integrated Water Resource Management (IWRM)

2. IWRM

IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

(GWP, 2000)

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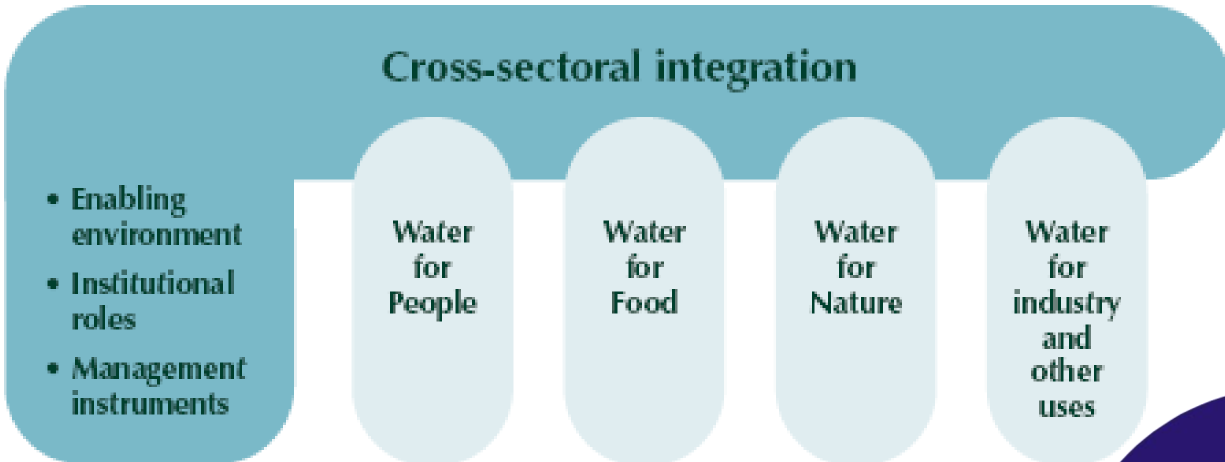
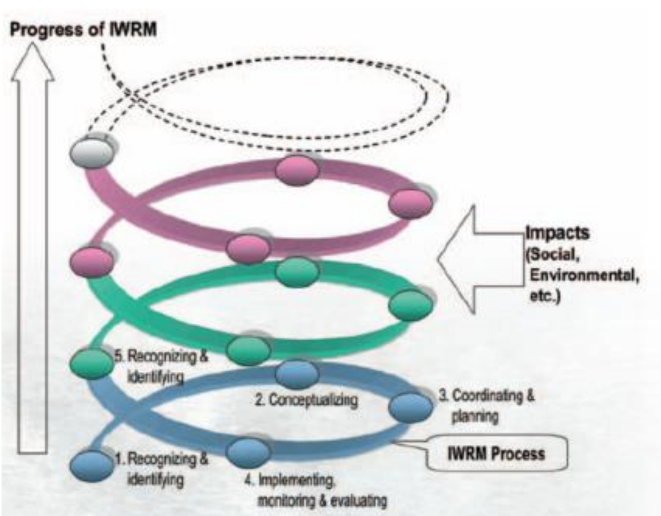
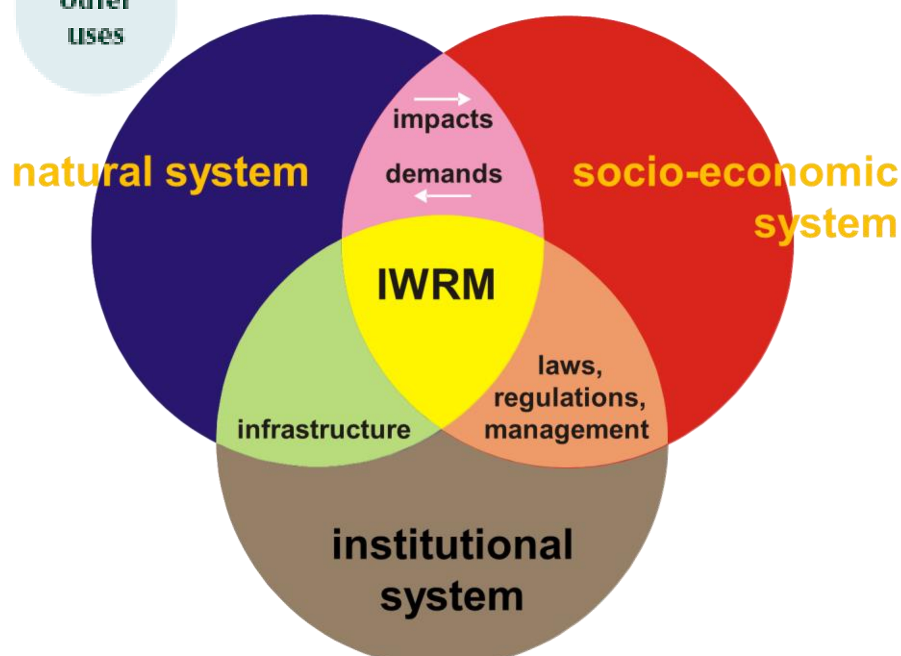
IWRM - integrating the use functions







3. Why use models in IWRM ?

- We want to manage our water resources systems
  - implement structural measures (reservoirs, river training works, irrigation areas, waste water treatment, etc.)
  - distribute the water to the various users
  - warn the stakeholders for floods and droughts
  - etc.
- But …
  - which measures to take ? and when?
  - what will be the effect of these measures ?
- Models help us to:
  - understand how the system works
  - helps us to quantify the effects
    - do they help us in achieving our objectives?
- Models are just tools – very useful but not magic

4. Example: Yellow River

Length: 5,464 km
Area: 795,000 km^2
Population: 107 million
Average flow: 57 km^3/year

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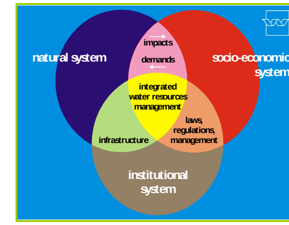
1. Backgr … IWRM



Fragile environment/ High sediment concentration flow

Suspend meander river

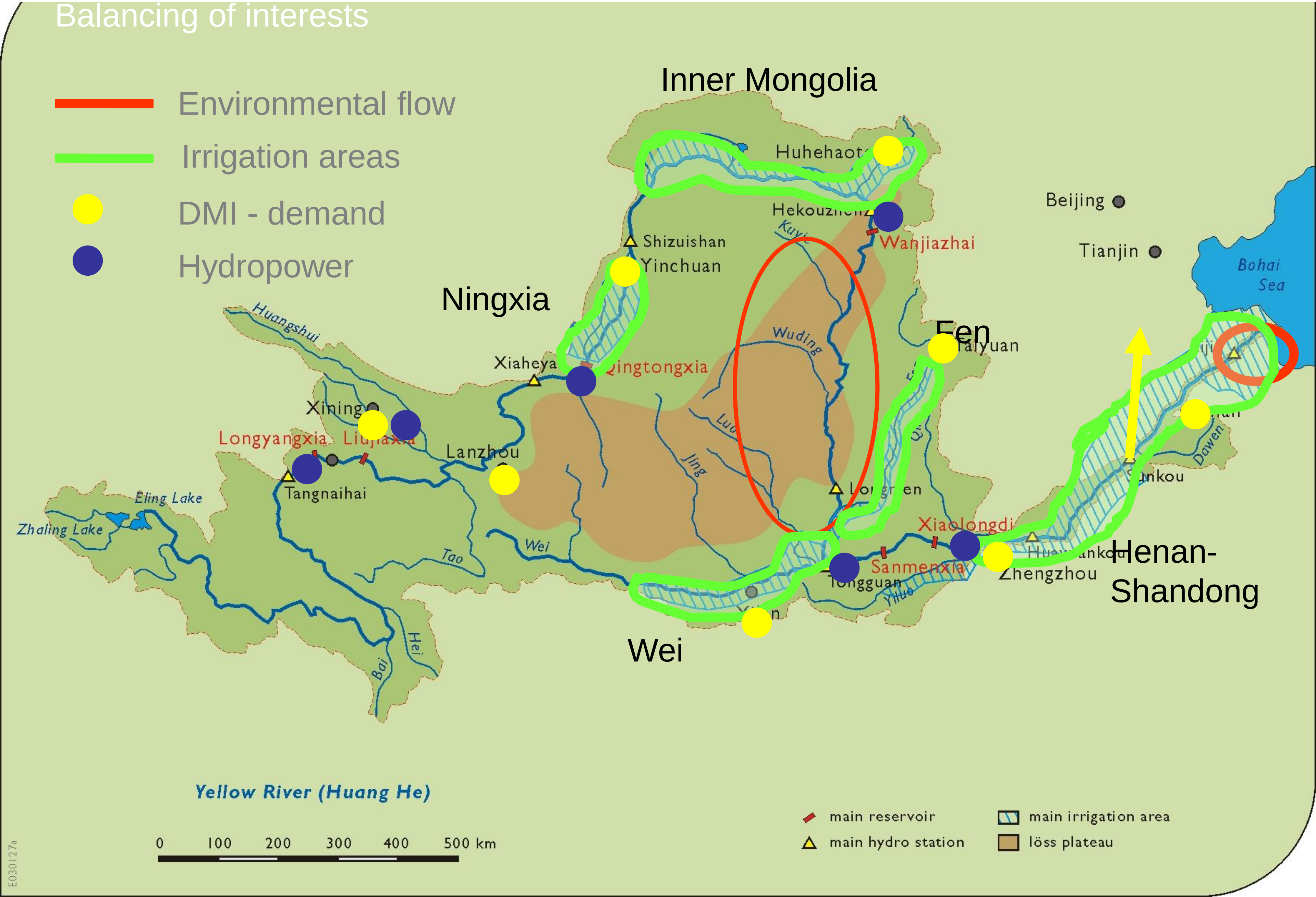
Internal factors

Year	Zero flow days	Year	Zero flow days
1972	19	1988	5
1974	20	1989	24
1975	13	1991	16
1976	8	1992	83
1978	5	1993	60
1979	21	1994	74
1980	8	1995	122
1981	36	1996	136
1982	10	1997	226
1983	5	1998	142
1987	17	1999	42

Water pollution / environmental deterioration

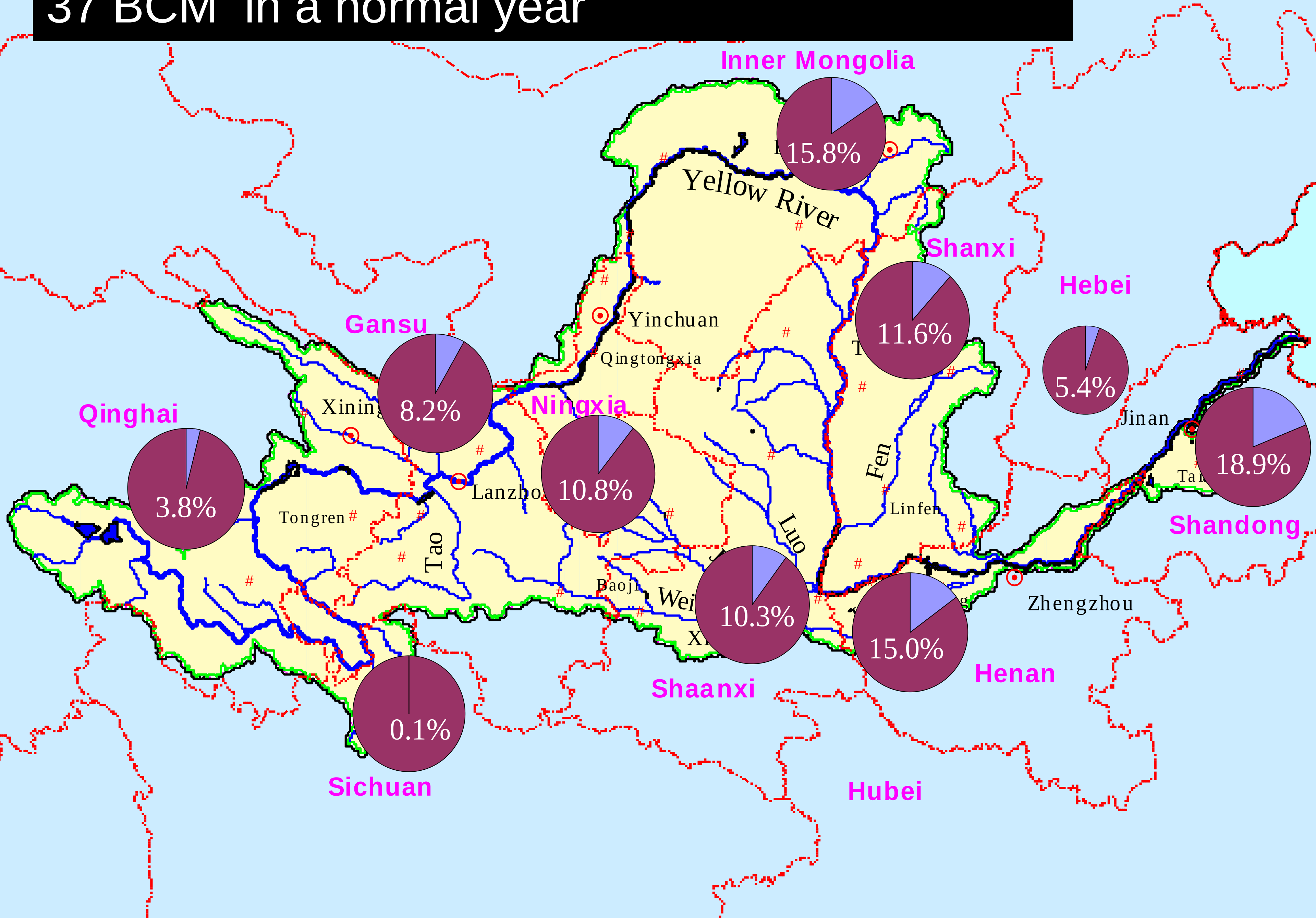
Toward IWRM

2. Water allocation in the YRB

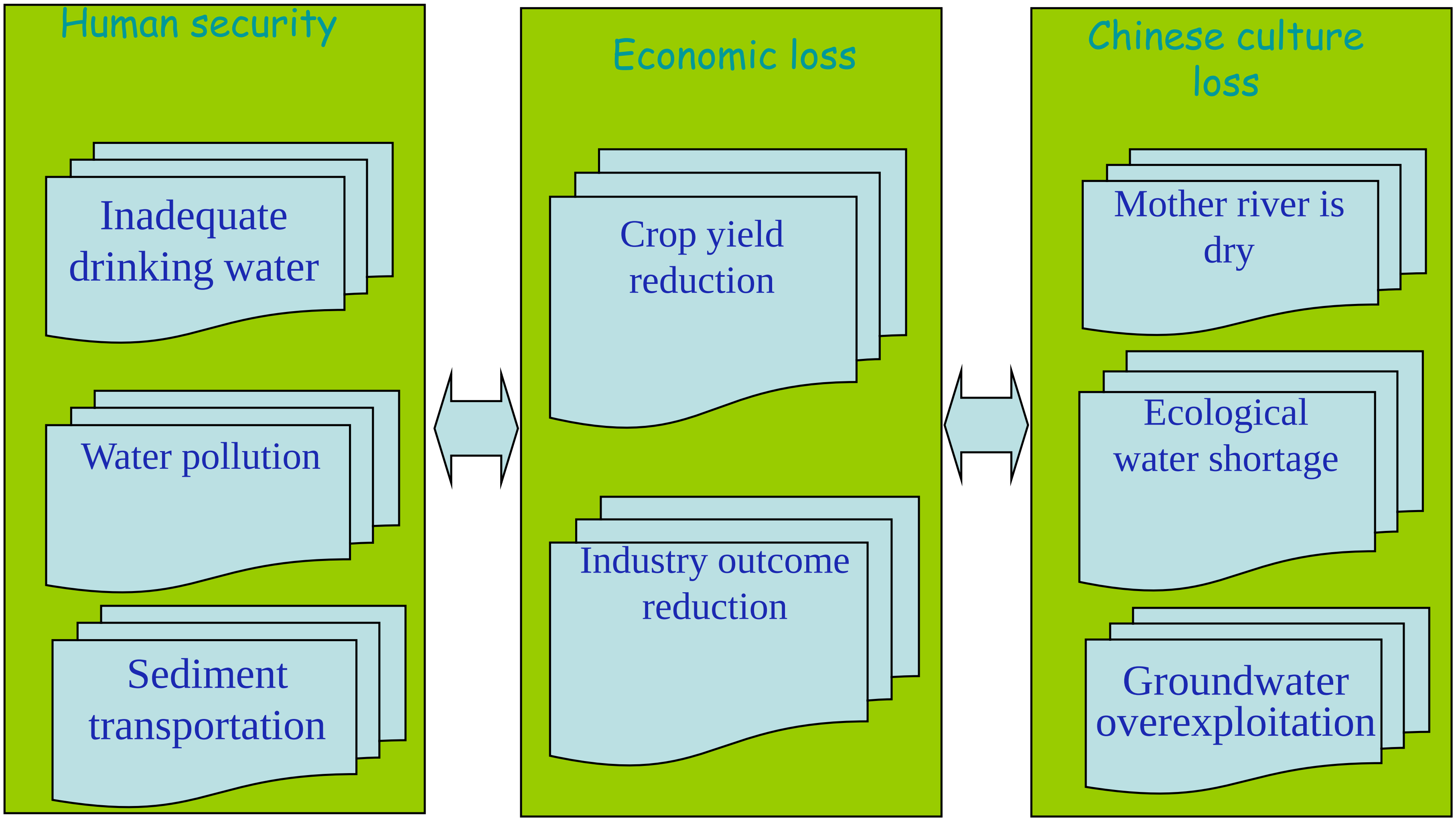


Inter-provincial transboundary

1987 inter-provincial water allocation scheme : 37 BCM in a normal year



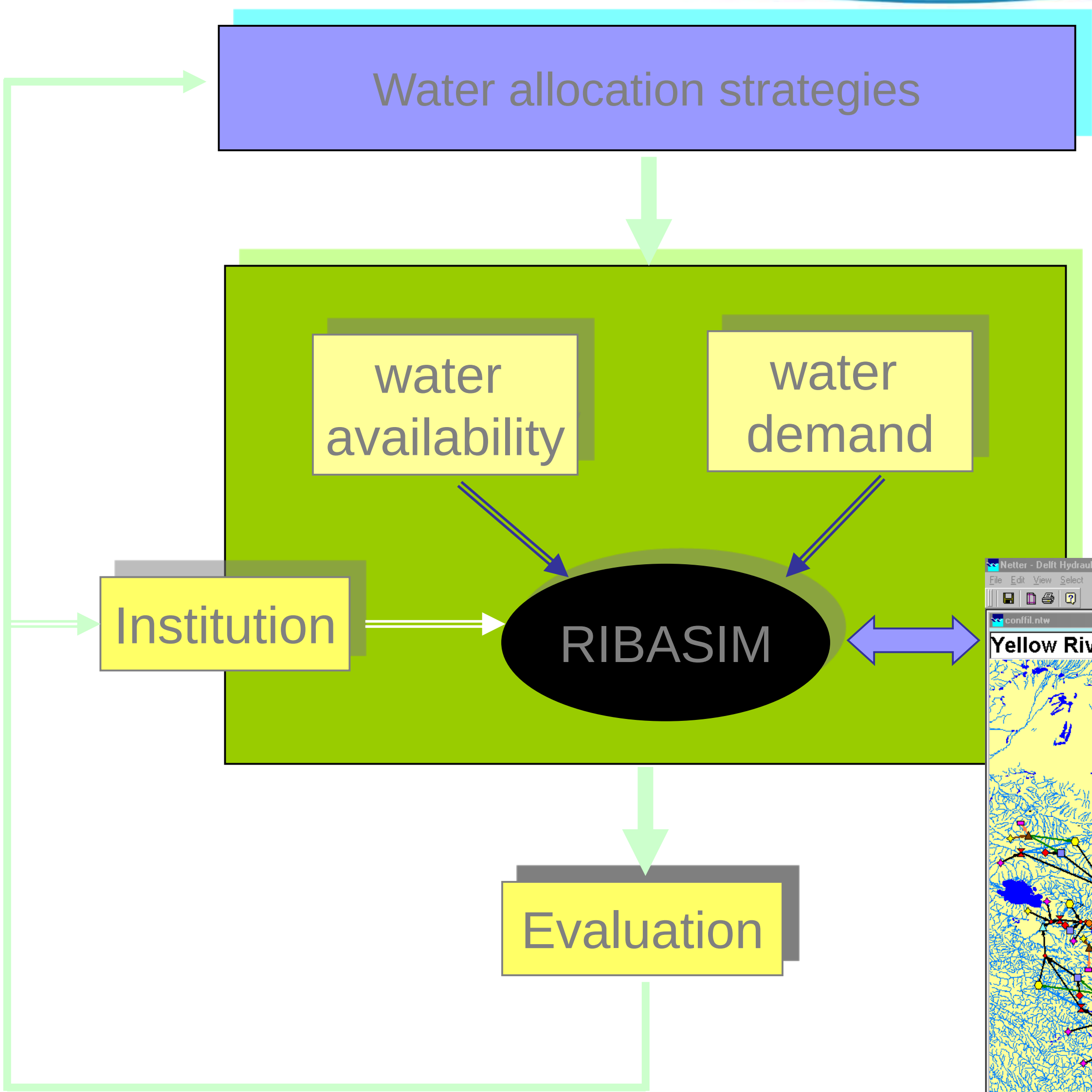
water shortage consequences . . .

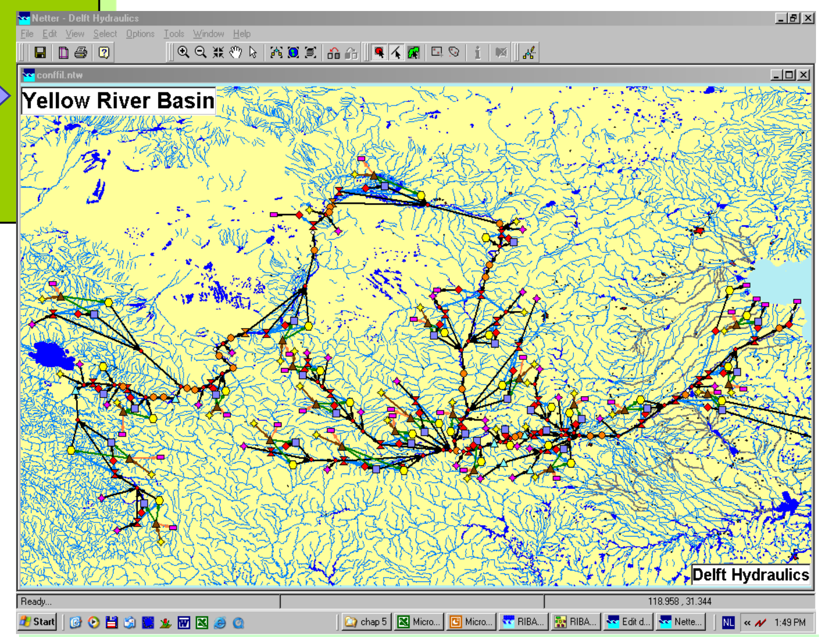


Need for a new strategy

- Since 1999, the 1987 scheme has been put into practice by YR water conservancy commission (YRCC) and zero flow is indeed prevented.
- However, differences of opinions and the huge gap between water supply and demand results in severe disputes among / within provinces and across water sectors.
- A more rational water allocation scheme is needed => **W**ho should get how much water, when, and how and why?????

Models help identify the alternative options





Schematization of the YRB water

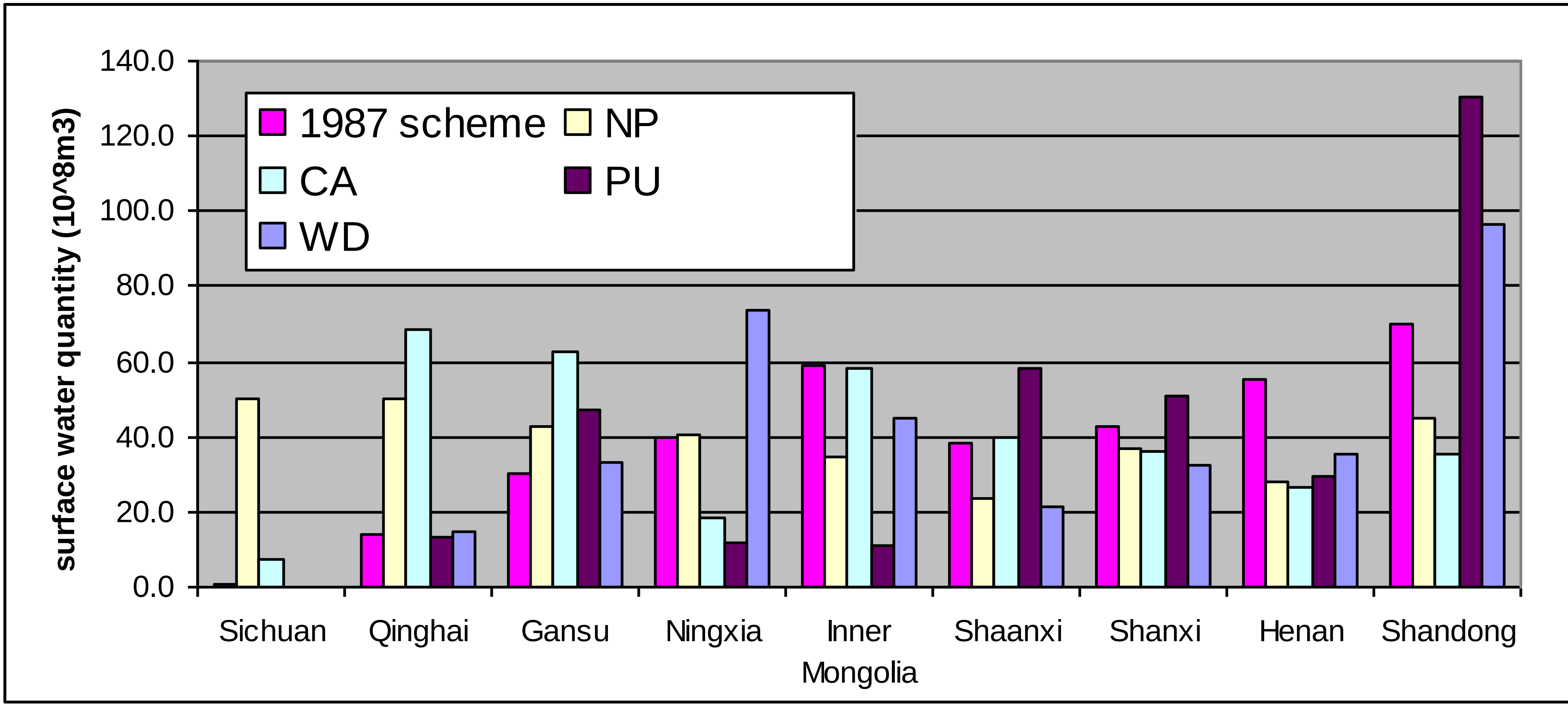
Establishment of strategies water allocation

- *4* types of 'equity' strategies
  - NP: **N**umber of **P**rovinces
  - CA: **C**atchment **A**rea
  - PU: **P**op**U**lation
  - WD: **W**ater **D**emand
- Combined with 6 different reserved water which is out of negotiation
- In total, ***24*** combinations of water shares for the 9 provinces in the YRB

6 types of reserved water

Components	1	1E	2	2E	3	3E
Domestic & municipal demand						
Industry demand						
Enviromental low flow						

Example results of water allocation case ‘1E’



Example results of water allocation for case ‘1E’

Province	1987 scheme	NP	CA	PU	WD
Sichuan	0.4	50.3	7.5	0.2	0.1
Qinghai	14.1	49.8	68.5	13.2	14.6
Gansu	30.4	42.8	62.4	47.0	33.1
Ningxia	40.0	40.7	18.2	12.0	73.8
Inner Mongolia	58.6	34.9	58.2	11.1	45.0
Shaanxi	38.0	23.5	40.0	58.4	21.5
Shanxi	43.1	36.8	36.0	50.5	32.4
Henan	55.4	28.2	26.2	29.5	35.2
Shandong	70.0	44.9	35.2	130.2	96.4
basin	350.0	352.1	352.1	352.1	352.1

Unit: 10^8 m3

preferred not prefr.

Evaluation of alternative surface water allocation schemes

Indicators for assessment of water allocation schemes

criteria	sub-aspect	indicator	unit
equity	water quota realization	actual realization of surface water quota	%
	spatial difference	fraction of internal to total water availability	%
efficiency	water use efficiency	irrigation water consumption / withdrawal	m3/m3
	water supply sufficiency	water supply / water demand	%
		time steps of water shortage in 10 years	%
		irrigation area with < 80% of supply/demand	%
	economic effectiveness	irrigation productivity	Yuan/m3
		(irrigation + industry) productivity	Yuan/m3
sustainability	vulnerability	utilization % of total renewable water (SW+GW)	%
		SW utilization % of total SW availability	%
		# of time steps of zero flow in 10 years	#

Score card of realized water allocation schemes for whole basin

population and water demand: year 2030

Indicators	1987 shemes	NP	CA	PU	WD
actual realization of water quota	☹	☹	☹	☹	☹
irrigation water consumption / withdrawal	☺	😐	😐	😐	😐
water supply / water demand	☹	☹	☹	☹	☹
# of time steps of water shortage in 10 years	☹	☹	☹	☹	☹
irrigation area with < 80% of supply/demand	☹	☹	☹	☹	☹
irrigation productivity	☹	😐	☺	😐	☹
(irrigation + industry) productivity	😐	😐	☺	😐	😐
utilization % of total renewable water (SW+GW)	😐	☺	☺	😐	😐
SW utilization % of total SW availability	😐	☺	☺	😐	😐
# of time steps of zero flow in 10 years	😐	☺	☺	☺	😐

☺ best 😐 middle ☹ worst

But, what are provinces' opinions of this preferred allocation scheme ??

Score card for preferred case of CA for provinces

against | no supt | no agst | support

remark	no agst	no agst	no supt	no supt	against	no supt	against	support	support
Indicator	**Sichuan**	**Qinghai**	**Gansu**	**Ningxia**	**Inner Mongolia**	**Shaanxi**	**Shanxi**	**Henan**	**Shandong**
fraction of internal to total water availability	☺	☺	☺	😐	☹	☹	☹	☹	☹
actual realization of water quota	☺	😐	☹	☺	☹	😐	😐	☹	☹
irrigation water consumption / withdrawal	☹	☹	☺	☺	😐	☺	😐	😐	☹
water supply / water demand	☺	☺	☹	☹	☹	☹	😐	☹	☹
time steps of water shortage in 10 years	☺	☺	☹	☹	☹	☹	☹	☹	☹
irrigation area with < 80% of supply/demand	☺	☺	☹	☹	☹	☹	☹	☹	☹
irrigation productivity	☹	☹	☹	☹	☹	😐	☹	😐	☺
(irrigation + industry) productivity	☹	☹	☹	☹	☹	😐	☹	☺	☺
utilization % of total renewable water (SW+GW)	☹	☹	😐	😐	😐	😐	😐	☺	☺
SW utilization % of total SW availability	☹	☹	😐	😐	😐	😐	😐	☺	☺
# of time steps of zero flow in 10 years	---	---	---	☹	---	😐	😐	---	☺

Conclusions and recommendations

- As demand grows, issues on water shortage and quality will escalate among states and across water sectors in the in future.
- Integrated Water Resources Management, involving all stakeholders, will help find the best approach (from different perspectives, there may be more than one ‘best’ approach)
- Models are very useful tools to provide transparent insight in the quantitative effects of interventions and measures, supporting decision making.