Water footprint application in specific geographical areas

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Water Footprint Network

Water Footprint Network

Mission: Promoting sustainable, equitable and efficient water use worldwide through development of shared global standards on water footprint accounting, sustainability assessment and guidelines for the reduction of impacts of water footprints.

Network: bringing together partners from academia, businesses, civil society, governments and international organisations.

Overview presentation

1. Water footprint concept

2. The study

3. Part 1: WF application at different geographical scales

4. Part 2: Policy framework and measures

5. Part 3: A practical WF assessment guideline

6. Overall Conclusions and next steps

1. the water footprint concept

- The WF is an indicator of water use that looks at both direct and indirect water use of a consumer or producer.

- The WF of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business.

- Water use is measured in terms of water volumes consumed (evaporated or otherwise not returned) and/or polluted per unit of time.

- A WF can be calculated for a process, a product, a consumer, group of consumers (e.g. municipality, province, state or nation) or a producer (e.g. a public organization, private enterprise).

- The water footprint is a geographically explicit indicator, not only showing volumes of water use and pollution, but also the locations.

Water footprint

Green water footprint

- volume of rainwater evaporated or incorporated into product.

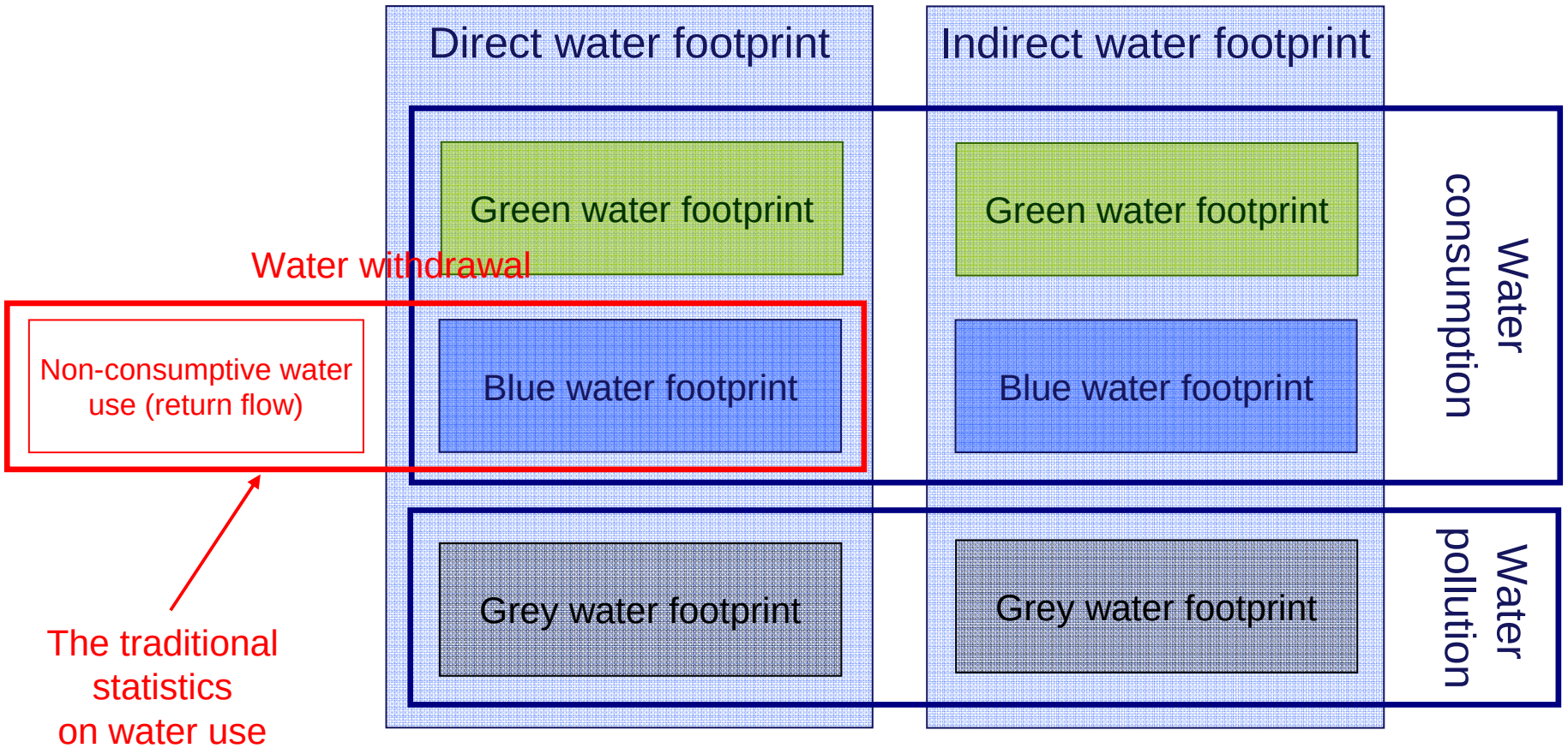
Blue water footprint

- volume of surface or groundwater evaporated, incorporated or returned to other catchment or the sea.

Grey water footprint

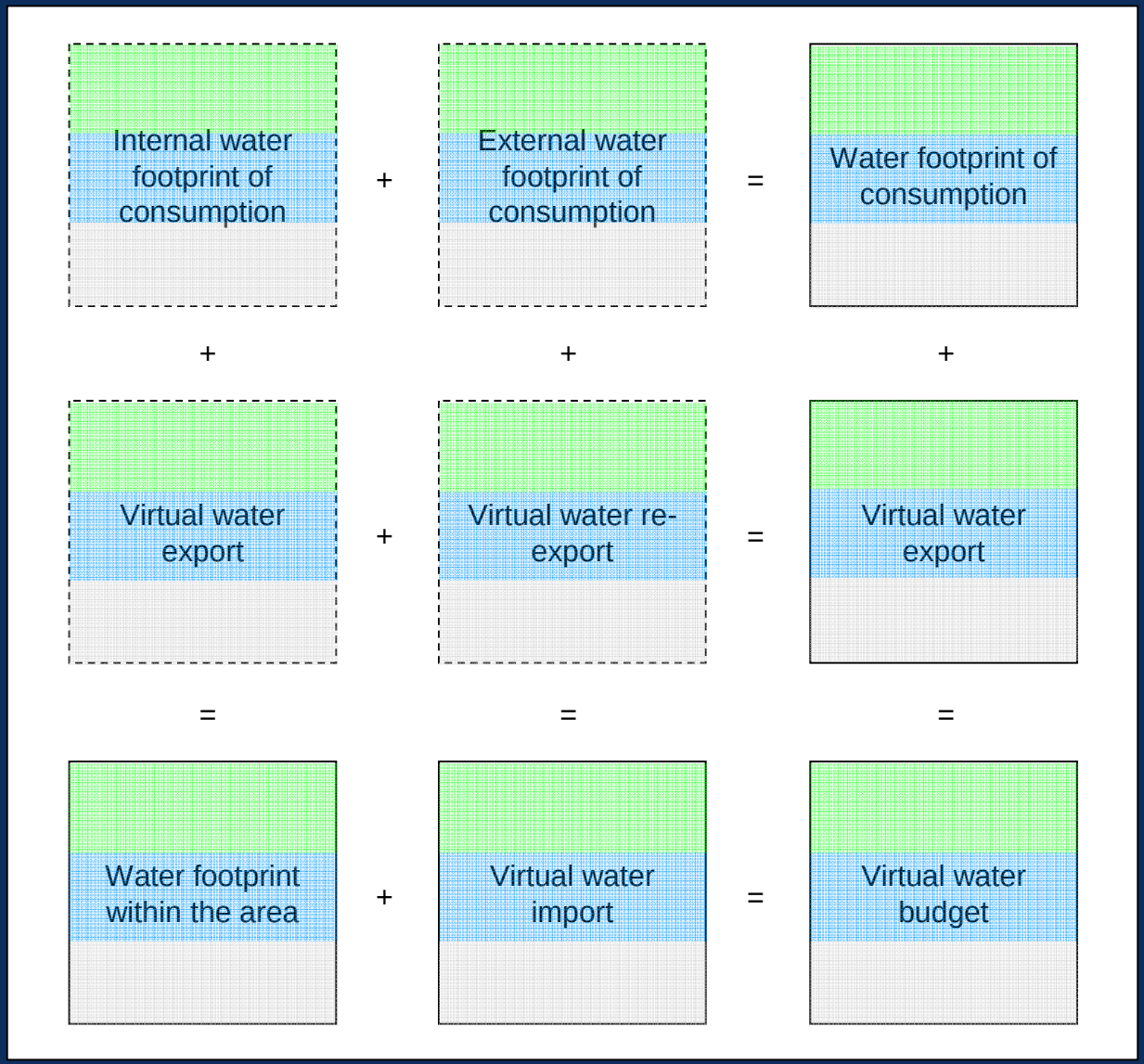
- volume of polluted water.

Components of a water footprint

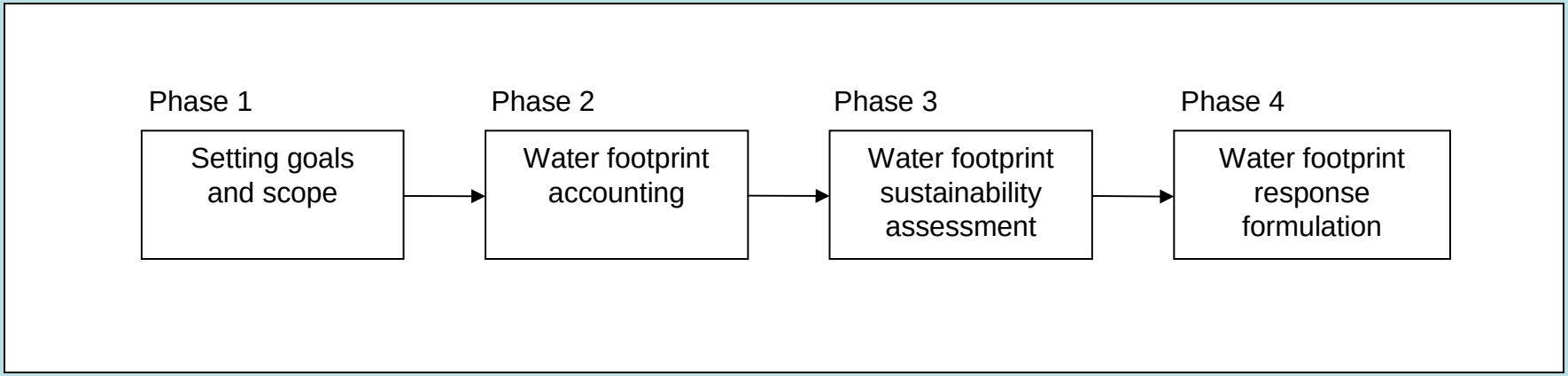


[Hoekstra, 2008]

WF accounting framework



Water footprint assessment



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The study

Objective of he study

To study the application of water footprint and related concepts in geographical locations

- to propose a conceptual framework for applying Water Footprint concept in a geographical area

- to identify and analyze measures to reduce water footprint and offset the impacts of water footprint.

Outline of the study

Part 1: Water Footprint application at different geographical scales

Part 2: Water Footprint policy framework and measures

Part 3: A practical water footprint assessment guideline

Sources of information

Case study publications

General publication

Questionnaires

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Part 1: WF assessment at different geographical scales

WF at different geographical scales

1. WF within a geographical area

- total amount of water that is used by all the production processes in the geography (green, blue, grey)
- virtual-water balance: net import of virtual water

2. WF of the consumers in the geographical area

1. Internal water footprint – WF inside the geography
2. External water footprint – WF in other geographies

Part 1: WF at different geographical scales
Main findings

- Literature review – Existing case studies (17)
- scales: global (1), national (10), regional / river basin (6)
- varying purposes of studies associated with the scale of investigation (table 1.3)
- inventory boundaries vary, majority do not include grey water footprint, internal/external water footprint, virtual water flows, water accounting scheme is comprehensive
- a variety of impact assessment indicators is used
- Environmental indicators:

  Capita / m3 – competition level

  Water stress and water scarcity (incl. and excl EFRs)

  Water availabity per capita n (m3/capita)

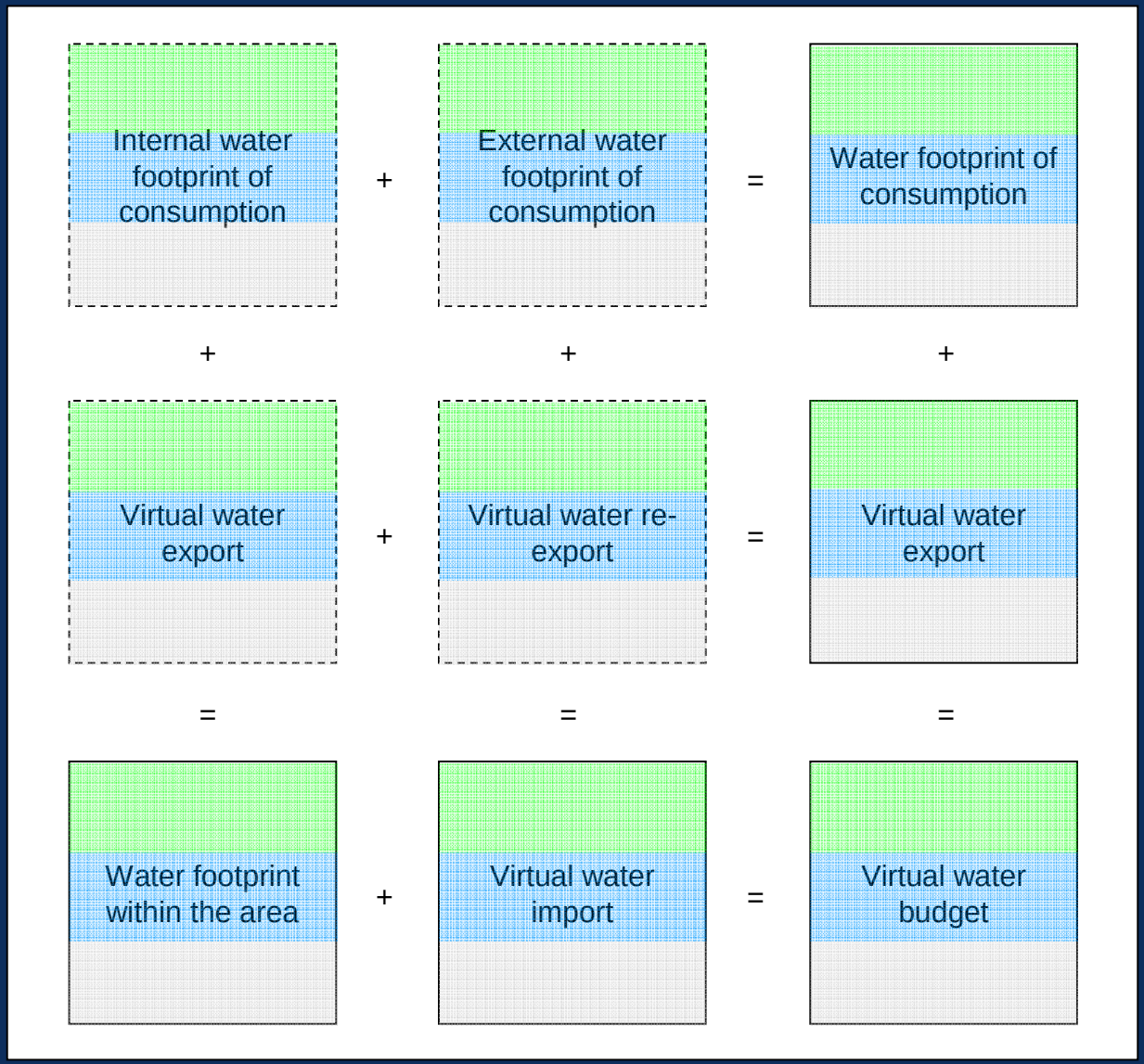
Existing case studies

Geographic unit	Source
GLOBAL	
International	Chapagain & Hoekstra (2004), Hoekstra & Chapagain (2008)
NATIONAL	
Indonesia	Bulsink et al. (2009)
Netherlands	Van Oel et al. (2009)
Spain	Aldaya et al. (2008), Garrido et al. (2010)
Germany	Sonnenberg et al. (2009)
China	Liu & Savenije (2008), Ma et al. (2006)
India	Verma et al. (2008), Kampman et al. (in press)
Cyprus	Zoumides (2008)
Tunisia	Chaded et al. (2008)
UK	Chapagain & Orr (2008)
Morocco	Hoekstra & Chapagain (2007)
REGIONAL AND RIVER BASIN	
Mancha Occidental Region	Aldaya et al. (2009)
Doñana Region	Aldaya et al. (2009)
Guadalquivir river basin	Rodríguez-Casado et al. (2009)
Guadiana river basin	Aldaya & Llamas (2008)
Lower Fraser valley and Okanagan basins	Brown et al. (2009), Schreier et al. (2007), Schendel et al. (2007)
Heihe river basin	Chen et al. (2005)

Part 1: WF at different geographical scales
Main findings cont'd

- Economic indicators
  - Economic water productivity (Eur/m3)
  - Water productivity (ton/m3)
  - Economic Agricultural productivity (Eur/ha)
- Social indicators
  - Water footprint per capita (m3/cap/yr)
  - Energy water productivity (kcal/m3)
  - Jobs (number)
- Different studies use and combine different indicators based on specific purpose and interest of study
- WF manual guidelines not followed

WF accounting framework



Part 1: WF at different geographical scales
Main findings cont'd

- Blue water mass balance approach (similar to blue water scarcity indicator proposed by Hoekstra et al., 2009)

- response options formulation related to scope of studies and the geographic scale:

  Improvement water productivity, Agricultural policy reform

  Trade policy reform, Development of food policies, etc

Part 1: WF at different geographical scales Conclusions

- WF and VWT a powerful tool for IWRM
- Manual provides the framework for WF application
- WF brings new information to Water Demand management
- More research is needed on:

1. WF assessment technical aspects:
    - Database improvement
    - WF industrial goods
    - Grey WF
    - Sustainability assessment indicators
    - Practical guidance non-scientific community
2. Insertion of WF assessment results into a decision-making system

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Part 2: Water Footprint policy framework and measures

WF policy framework

Role of water footprint in a policy environment:

- to guide policy making and design of practical measures
- to quantitatively evaluate policies and practical measures

WF policy environment

The water footprint policy environment:

- water policy
- agricultural policy
- environment policy
- trade policy
- energy policy

WF policy framework

Water policy

- National water statistics, national water plan and river basin plans
- Indicator beyond GDP
- Water pricing
- Allocating water more efficiently
- Drought management
- Financing water efficiency
- Fostering water efficient technologies and practices
- Development of a water-saving culture
- Improvement of knowledge
- Promote coherence between water and other policies: environmental, agricultural, energy, trade, foreign policy

WF policy framework

Agricultural policy

- Main water consumer (86% green and blue WF)
- Optimal cropping pattern planning (suitable to climate conditions)
- Allocate water where its value added is highest
- Increase water productivity
- Water-saving irrigation techniques along the whole supply chain (storage – distribution – application)
- Reduce/eliminate or reform of environmentally harmful subsidies
- Reduce pollution - Non-point source pollution indicator – Grey WF

WF policy framework

Environmental policy

- Include WF and VWT analysis in the river basin plans.
- Plan water allocation taking the environmental flows into account.
- Implement WF reduction measures ensuring environmental flow requirements and ambient water quality standards.

WF policy framework

Trade policy

Water saving through trade

- National water saving

  A water scarce nation can save water by importing a water-intensive commodity instead of producing it domestically.

- Global water saving

  International trade can save water globally if a water-intensive commodity is traded from an area with high to an area with low water productivity.

- WTO – Doha Development Round

WF policy framework

Energy policy

The water sector is becoming more energy-intensive

- desalination
- pumping deeper groundwater
- large-scale (inter-basin) water transfers

The energy sector is becoming more water-intensive

- biomass

Part 2: WF policy framework
Conclusions and discussion

- WF assessment can:
  - Inform and evaluate cross sectoral policy making
  - Build citizen awareness
  - Inform water allocation decisions at different levels
- Currently no systematic and practical framework exists
- Better understanding and agreement needed on:
  - Water offsetting and water neutrality
  - VWT consideration in Doha Development round (WTO)
  - Developing countries perspectives

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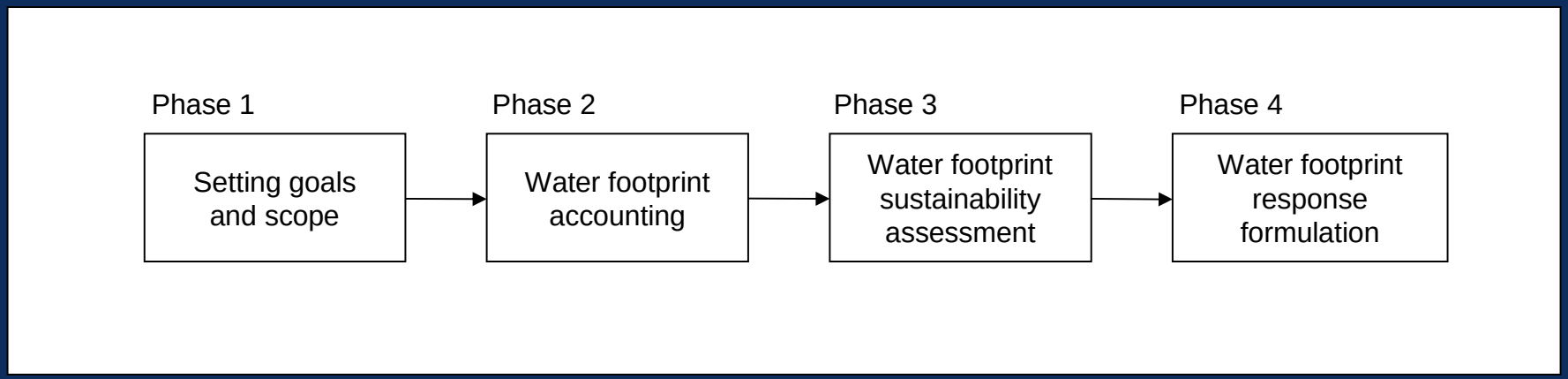
Part 3: Guideline for WF application in specific geographical areas

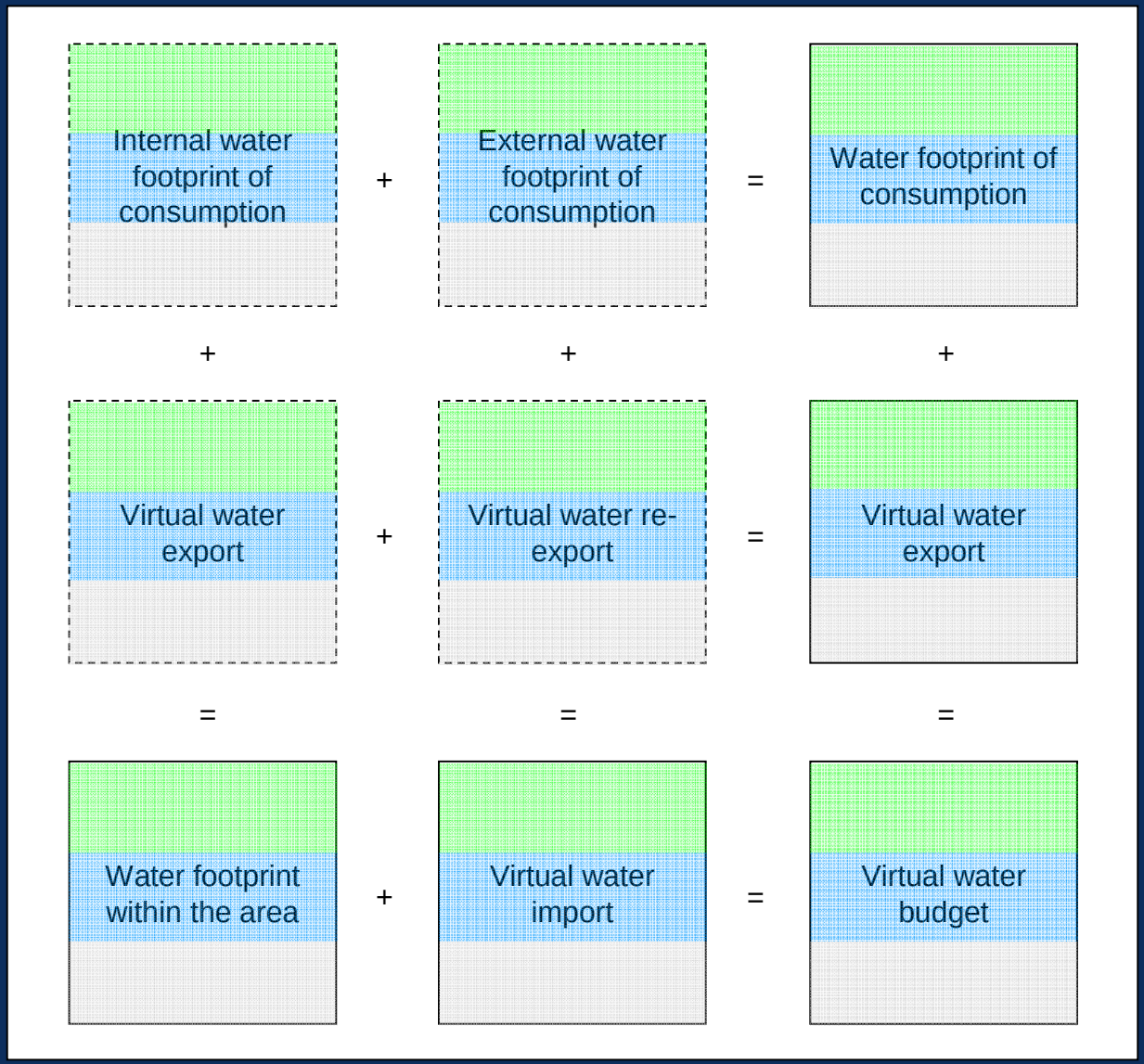
WF assessment steps



WF assessment data

- Phase1: scope and goal
  - specific geographic area
  - sustainability of water footprint within the area
  - Sustainability of water footprint of consumption of the area
- Phase 2: WF accounting
  - National water accounting scheme applies at the geography

Geographic WF accounting framework



WF assessment data

- Phase 3: WF sustainability assessment
  - Environment:
    - green, blue water scarcity
    - water pollution level
  - Economy:
    - Economic water productivity
  - Social
    - Link to import social issue associated with water:
    - WSS and food security, energy water productivity
    - (Liu and Savenije, 2008)

WF assessment data

- Phase 3 cont'd: WF sustainability assessment
  - Observations:

    Sustainability of external water footprints →

    Water Footprint Impact Index (WFII)

- Phase 4: WF response formulation
  - Approach: avoid, reduce, offset
  - Not yet **q**uantitative evaluation of responses

WF assessment data

- Additional aspects
  - Presenting WF accounting data for sectors and users

    C as a contribution ratio: $C_{user,area} = WF_{user,area} / WF_{area}$

  - Presenting WF sustainabilty assessment data for users

    Contribution of a user to blue, green water scarcity (WS) and water Pollution Level (WPL)

    $WS_{blue,user,area} = WF_{user,area}/WA_{blue,area}$

WF scope and goals guideline

Scope and goal topic	Specific question
Goal	Why is the water footprint assessment done?
Geographic scope	Which area and type (city, basin, district, country), what geographic resolution of data
Temporal boundary	Which periods at what time step is considered (year, month)?
Sector Boundary	Which sectors will be investigated, to which subsector level (ag, domestic, industry)
WF accounting boundary	Will virtual water trade be incorporated? Calculating blue, green, grey? Where is the analysis truncated and why?
WF sustainability assessment boundary	Focus on environment (WS and WPL), or also social and economic sustainability, or all? Calculate indicators or weighed indexes or both?

WF accounting guideline

water user sectors	Internal water footprints															
	WF_{area}				$WF_{cons,area,int}$				$V_{e,area}$				$C_{user,area}$			
	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	
Agriculture																
Industry																
Domestic																
Total																

$/WA_{,area}$

water user sectors	External water footprints															
	$V_{i,area}$				$WF_{cons,area,ext}$				$V_{e,r,area}$				$C_{user,ext,area}$			
	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	tot
Agriculture																
Industry																
Domestic																
Total																

water user sectors	Internal and external water footprints combined															
	$WF_{cons,area}$				V_e				$VW_{budget,area}$				$C_{user,cons,area}$			
	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	tot	bl	grn	gry	tot
Agriculture																
Industry																
Domestic																
Total																

WF Sustainability guideline (1)

water user sectors	Internal water footprints																										
	WF_{area}									$WF_{cons,area,int}$									$V_{t,area}$								
	blue			gm			grey			blue			gm			grey			blue			gm			grey		
	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC
Agriculture																											
Industry																											
Domestic																											
Total																											

WF Sustainability guideline (2)

Water user sectors	external water footprints															
	$WF_{cons,area,ext}$				$V_{i,area}$				$V_{e,area}$				V_{in}			
	blue	green	grey	total	blue	green	grey	total	blue	green	grey	total	blue	green	grey	total
	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII
Agriculture																
Industry																
Domestic																
Total																

WF Sustainability response guideline

STEPS

1. definition of water footprint response objectives

$$WS_{,user,area} = WF_{,user} / WA_{,area}$$

2. definition and quantitative evaluation of water footprint response strategies

3. design of policy and practical response measures

WF reduction scenario presentation

water user sectors	Internal water footprints															
	$WF_{a\ area}$				$WF_{cons,\ area,\ int}$				$V_{q,area}$				$C_{user,\ area}$			
	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	
Agriculture	-X															
Industry																
Domestic																
Total																

water user sectors	External water footprints															
	$V_{i,area}$				$WF_{cons,\ area,\ ext}$				$V_{sr,\ area}$				$C_{user,ext,area}$			
	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	tot
Agriculture	+Y															
Industry																
Domestic																
Total																

water user sectors	Internal and external water footprints combined															
	$WF_{user,\ area}$				V_{q}				$VW_{budget,area}$				$C_{user,\ cons,area}$			
	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	tot	bl	gm	gry	tot
Agriculture																
Industry																
Domestic																
Total																

WF reduction scenario evaluation (1)

water user sectors	Internal water footprints																											
	WF_{area}									$WF_{cons,area,int}$									$V_{e,area}$									
	blue			grn			grey			blue			grn			grey			blue			grn			grey		
	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC	WS	EWP	CAL	WS	EWP	CAL	WPL	EC	SOC
Agriculture																											
Industry																											
Domestic																											
Total																											

WF reduction scenario evaluation (2)

Water user sectors	external water footprints															
	$WF_{cons,area,ext}$				$V_{i,area}$				$V_{e,r,area}$				V_{ri}			
	blue	green	grey	total	blue	green	grey	total	blue	green	grey	total	blue	green	grey	total
	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII	WFII
Agriculture																
Industry																
Domestic																
Total																

WF guideline conclusions

Guideline provides additions to the manual

- structured guideline sheets for WF acc, sust ass, resp
- use of contribution ratio C and Ws_{user} and WPL_{user}
- expand use of WFII
- three step approach in response formulation
- a quantified scenario analysis approach for WF responses

WF guideline R&D

Guideline is a prototype, further development is needed on:

- social and economic indicators
- deepen understanding of quantification of policy measures
- further develop guideline on:
  - Sustainability assessment of internal and external Wfs
  - Social and economic impacts of external WFs
  - multiple time periods with higher level resolution
  - Response scenario evaluation needs completion
  - Contribution ratios
- green water availability and green WS concepts
- Testing and refining guideline in various geographical areas

6

Overall conclusions and next steps

Conclusions

1. Study is first comprehensive overview of:
   - WF application in specific geographical areas
   - overview of responses and measures
   - findings provide guidance to the next version manual

2. None of the case studies present full WF assessment

3. No quantification of policy and practical measures in WF reductions and WF sustainability

4. prototype guideline for WF application in geographic areas

Next steps

Further work is needed

Testing WF guideline in variety geographical areas:

- Kenya (Lake Naivasha)
- Brazil (Sao Paolo, National water plan)
- Chile (Huasco, Elqui and Rapel rivers)
- China (Beijing Municipality)
- Spain (Camp de Dalias, Jugar, Nansa (?))
- Peru (Piura region)
- India
- Nile basin

Key areas R&D

- Grey WF
- Analysis and testing of WF sustainability indicators
- Elaborate and test response scenarios
- Test the guideline in the context of business WF assessment
- Test the effectiveness of the guideline in decision making processes

Thank you very much for your attention