Water Supply and Demand Situation Modeling using VENSIM.

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Accra Re-SAP V Meeting

Coconut Grove, Accra, 29 August 2011

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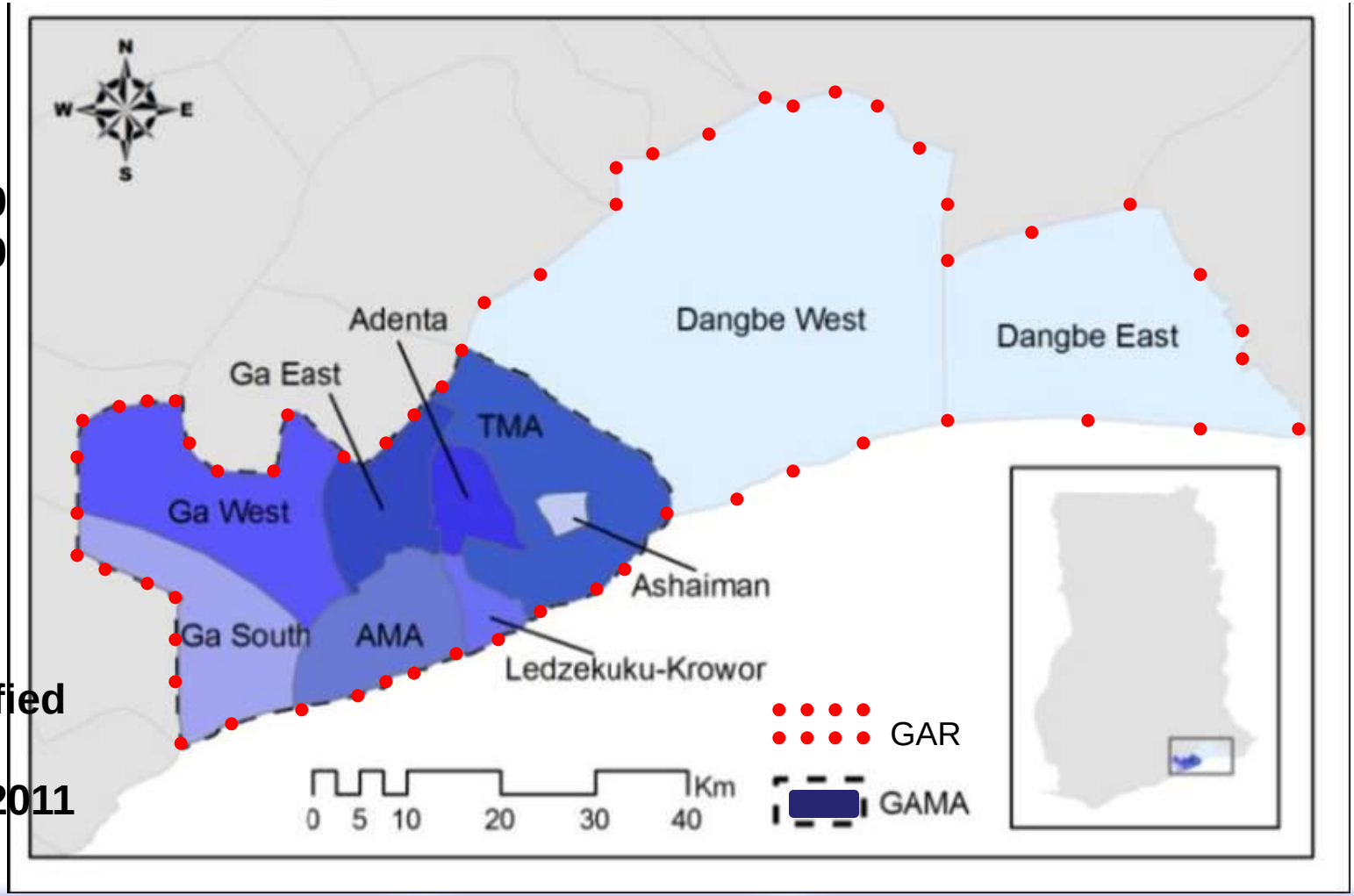
URAdapt

Managing Water at the Urban-Rural Interface: The key to climate change resilient cities

- **Introduction**
- **Motivation**
- **Modeling Approach**
- **Projections Of Urban Water Demand**
- **Development of Scenarios**
- **Way Forward**

Definition of Accra (GAMA)

1.3 mill - 1984
2.7 mill – 2000
4.0 mill – 2010



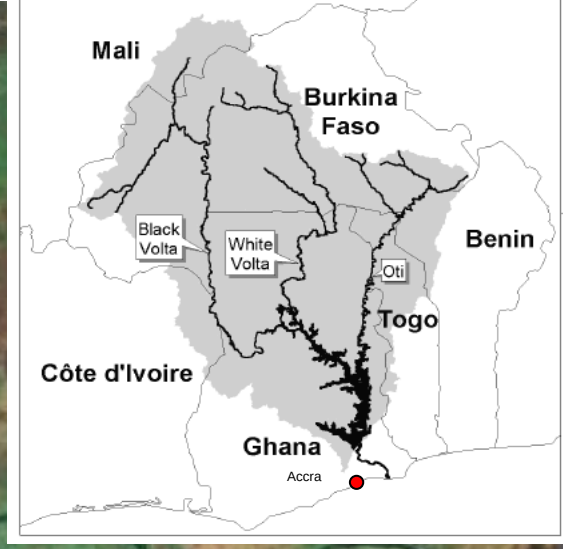
Source: Modified from Adank *et. al*. 2011

Accra Metropolitan Area | **Ga Districts** | **Tema Municipal Area**

Ledzekuku-Krowor | **Adenta** & **Ashaiman Municipality**

Volta river

Sources of surface water supply to Accra Urban Area.



Dodowa

Densu river

ACCRA URBAN AREA

Accra, Ghana

Image © 2007 TerraMetrics

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Water Supply to Accra

Mr Bagbin said all communities in Accra and Tema received water through rationing, adding, plans were far advanced at resolving the water supply deficit in the Accra Tema Metropolitan Area by the implementation of some projects.

66MCM/yr

The projects included the construction of 40mdg plant by a Chinese Contractor, China Gezhouba Water and Electric (Group) Company Ltd, the project which was commenced this year is on-going and will be completed in 2013.

133MCM/yr

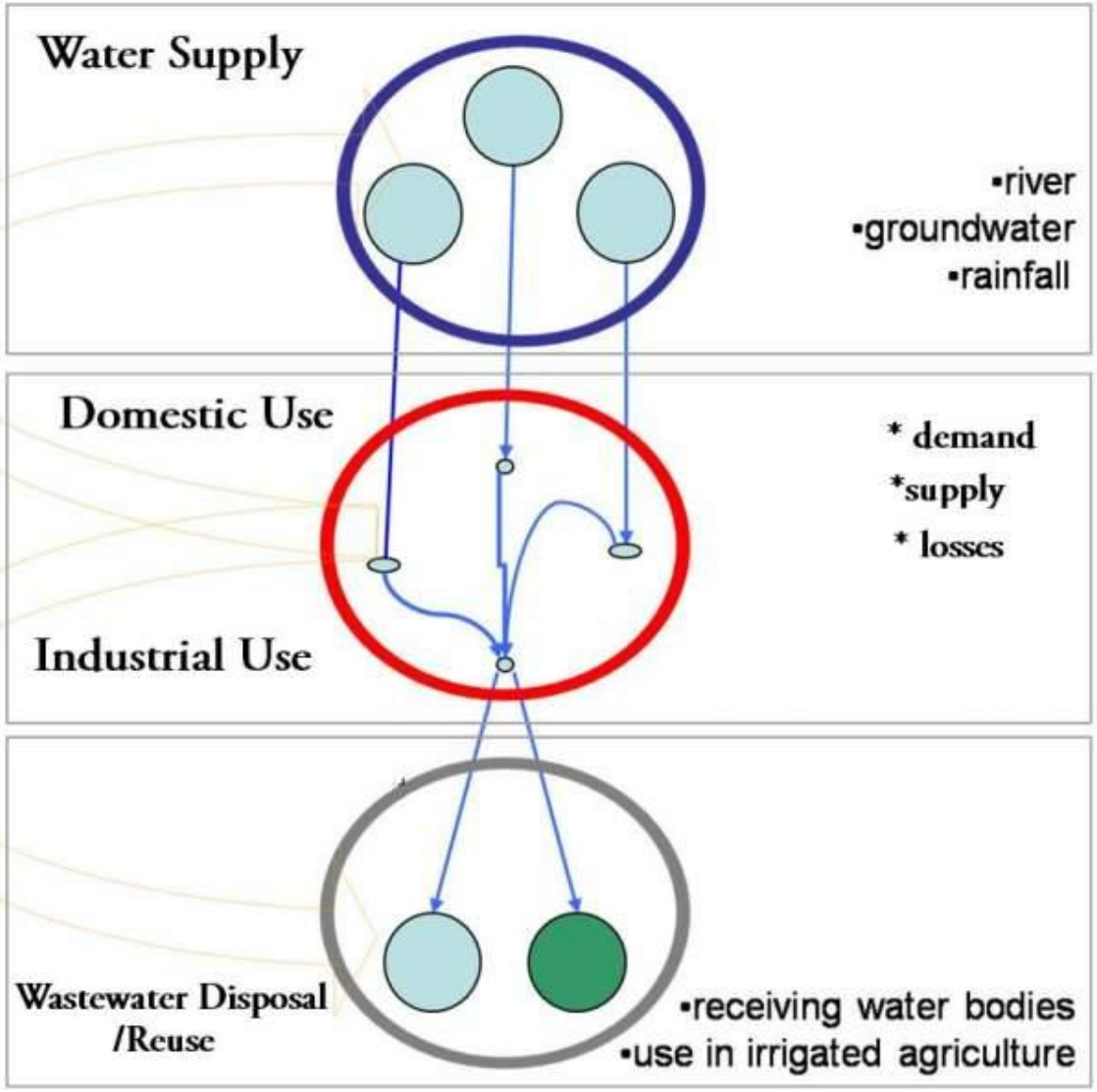
He said plans were afoot to construct an 80mgd Water Treatment Plant at Asutuare to supply water to Accra and Tema by a Build, Operate and Transfer (BOT) contract. Den Water, a special purpose company between Ghana Water Company Ltd and Denys of Belgium is to implement the project.

The third project is the rehabilitation and expansion of the existing Kpong Water Treatment Plant to deliver an additional 6.5mgd, principally to free Zones Board and the Tema Industrial Areas both in Tema.

Mr Bagbin said water supply to the Tema West constituency will improve considerably within the next two years and finally become regular in four years time when the entire project was completed.

Accra Urban Water System.

What water are we talking about?



Research Motivation

1. The fast growing population, urbanization and the expansion of development and economic activities that exert pressure on available water resources.
2. Importance of understanding the extent of the existing problems in the water sector.
3. Decision makers lack a tool that can aid them in planning and management.

Aim

To evaluate the existing conditions and other expected future scenarios taking into account different factors (non-climatic and climatic) that affect water supply and demand.

VENSIM (VENtana SIMulation)

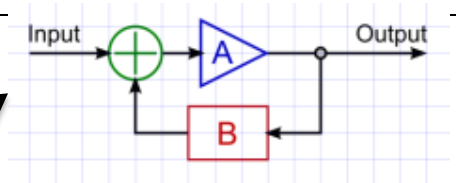
VENSIM is a visual modeling tool that allows you to conceptualize, document, simulate, analyze, and optimize models of dynamic systems.

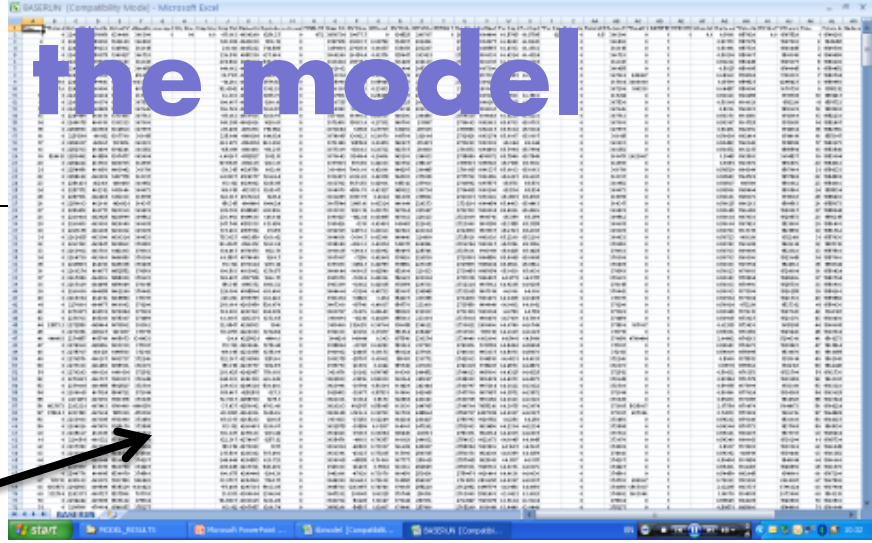
DYNAMO	iTHINK/STELLA	POWERSIM	VENSIM

Model Properties

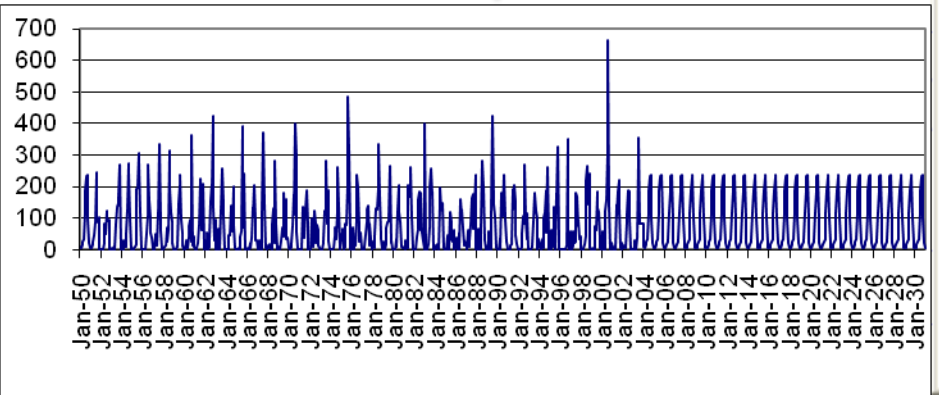
- **VISUALIZATION of relationships between parameters.**
- **WITH EACH TIME STEP, parameters can change; you can play with them.**
  - **You can explore and better understand interaction between system components**
- **ERROR MESSAGES: when units are not compatible, when values become unrealistic during modeling,**

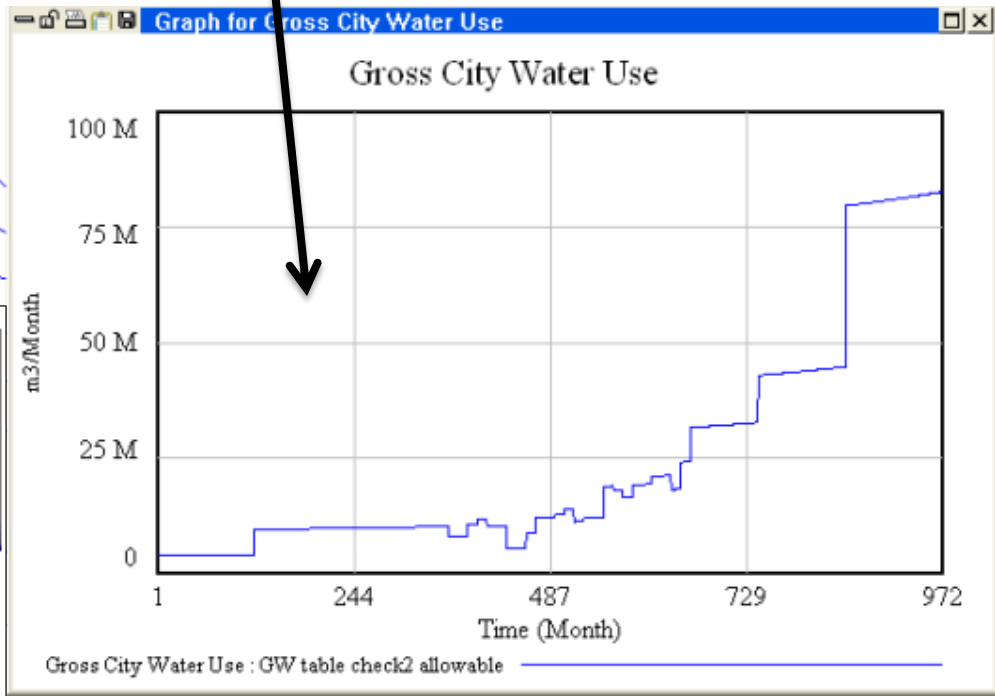
Working of the model





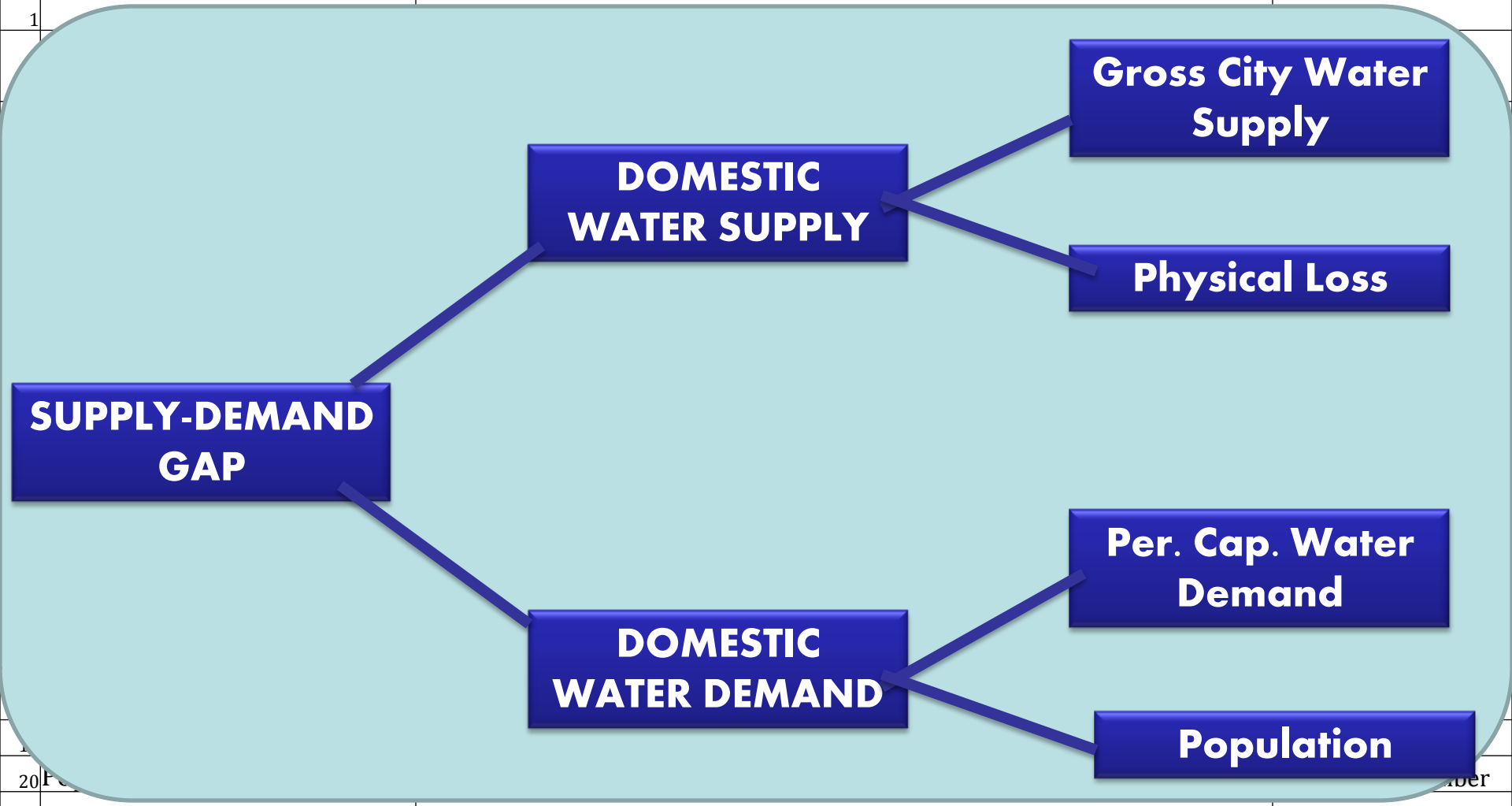
- System Dynamics
- Time series data input (ET, Rainfall, Water supply etc)
- Outputs : Excel format or VENSIM graphs





Model Parameters

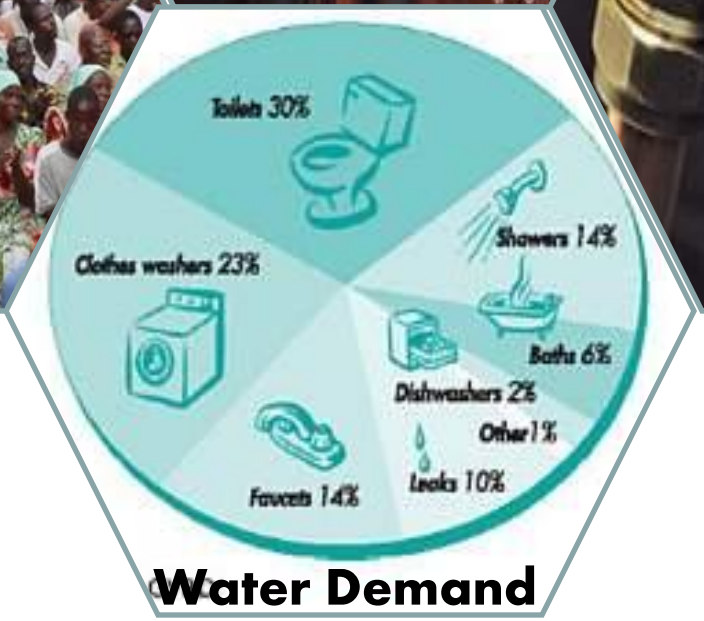
No	Parameter	Equation/Value	Units
1			
20			
21			



Projections Of Urban Water Demand

Population Growth

Demand Management



Water Demand

Projections Of Urban Water Demand

Population Growth

Per Capita Water Demand

Accra Population Projections

Growth Rate	Source	Key Assumption
3.4;6.1;8.9	GSS, 2002 *1984-2000 Growth rate of AMA;GD;TMA	
3.5	TAHAL Group, 2008 (*for GAMA*)	Growth will occur in urban Accra rather than Tema and Ga Districts
4.4	GSS, 2005 *1984-2000 Av. Growth rate of GAR.	
6.1		Av. Growth rate of the district of GAMA bt. 1984-2000

Lower Projection

Middle Projection

High Projection

Accra Water Demand Projections

Water Demand Per Capita (lpcd)

	2007	2011	2015	2025
Accra Rural *	54	60	63	72
Accra Urban*	139	141	143	145
Total Accra*	139	141	143	145
Adank, 2011**	130	130	130	130
Adank, 2011***	130	135	135	142

High Projection

Low Projection

Middle Projection

Kasie, 2007 – 150lpcd; Adank *et al*, 2011- 130lpcd

*(TAHAL, 2008); **Without economic growth;

***With economic growth

Scenarios Of Development

		Per Capita Water Demand Projections		
Population Projections		Low (L) (130)	Moderate (M) (133-142)	High (H) (141-145)
	Low (L) (3.5%)	LoLo (Low)	LoMo	LoHi
	Moderate (M) (4.4%)	MoLo	MoMo (Middle)	MoHi
	High (H) (6.1%)	HiLo	HiMo	HiHi (High)

Source: GSS, 2002; GSS, 2005;TAHAL, 2008; Adank *et al*, 2011

Scenarios Of Development

		Per Capita Water Demand Projections			
		Low (L) (130)	Moderate (M) (133-142)	High (H) (141-145)	Climate Change
Population Projections	Low (L) (3.5%)	LoLo (Low)	LoMo	LoHi	?
	Moderate (M) (4.4%)	MoLo	MoMo (Middle)	MoHi	?
	High (H) (6.1%)	HiLo	HiMo	HiHi (High)	?
	Climate Change	?	?	?	?

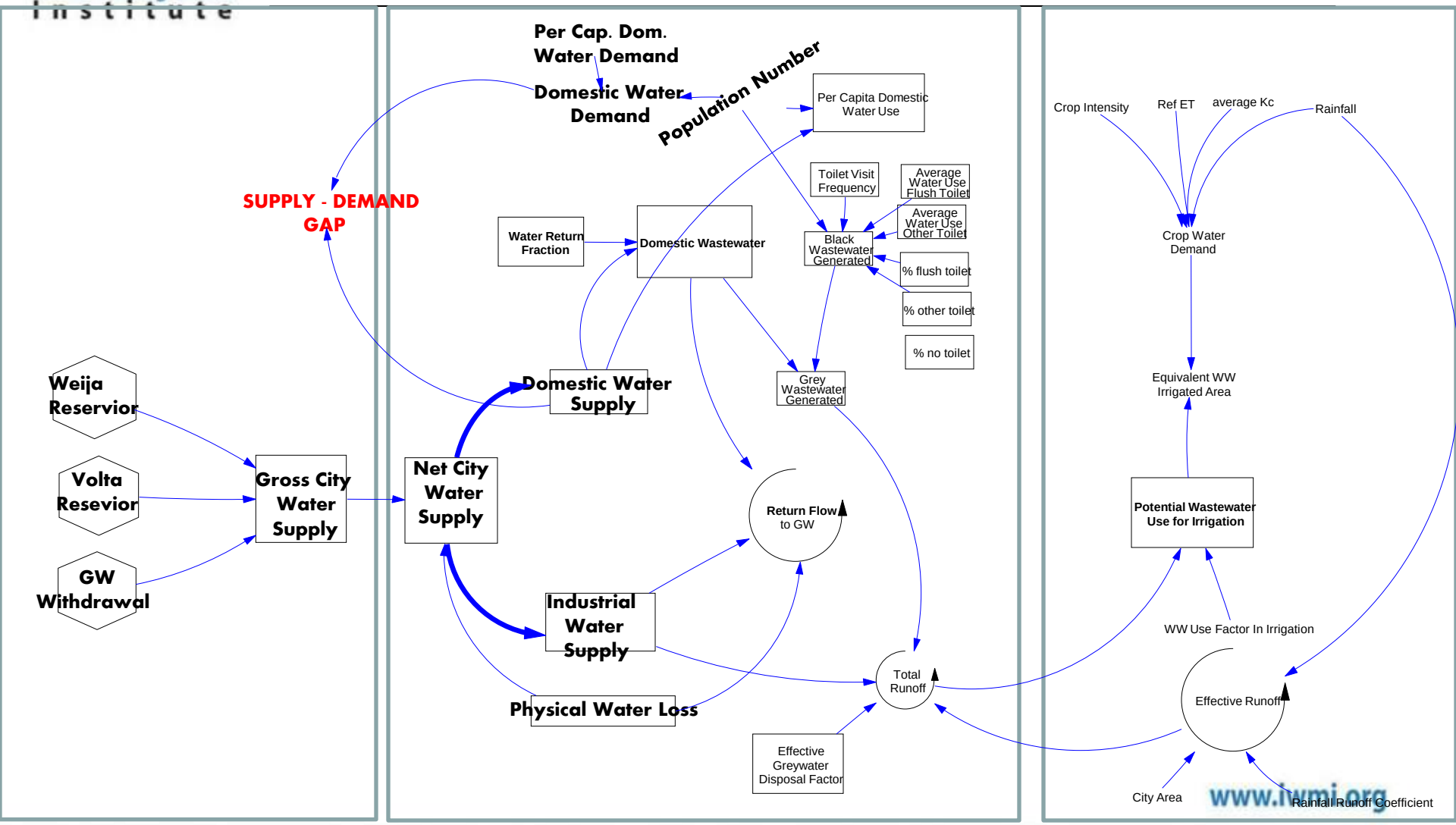
Source: GSS, 2002; GSS, 2005;TAHAL, 2008; Adank *et al*, 2011

Scenarios Of Development

What else could be done?

- ***Water supply/demand situation under different demographic and water use scenarios, that include climate and socio-economic drivers***
- ***Waste water generation and management with and without climate change***
- ***Evaluation of proposed demand management activities using VENSIM***

Model Layout



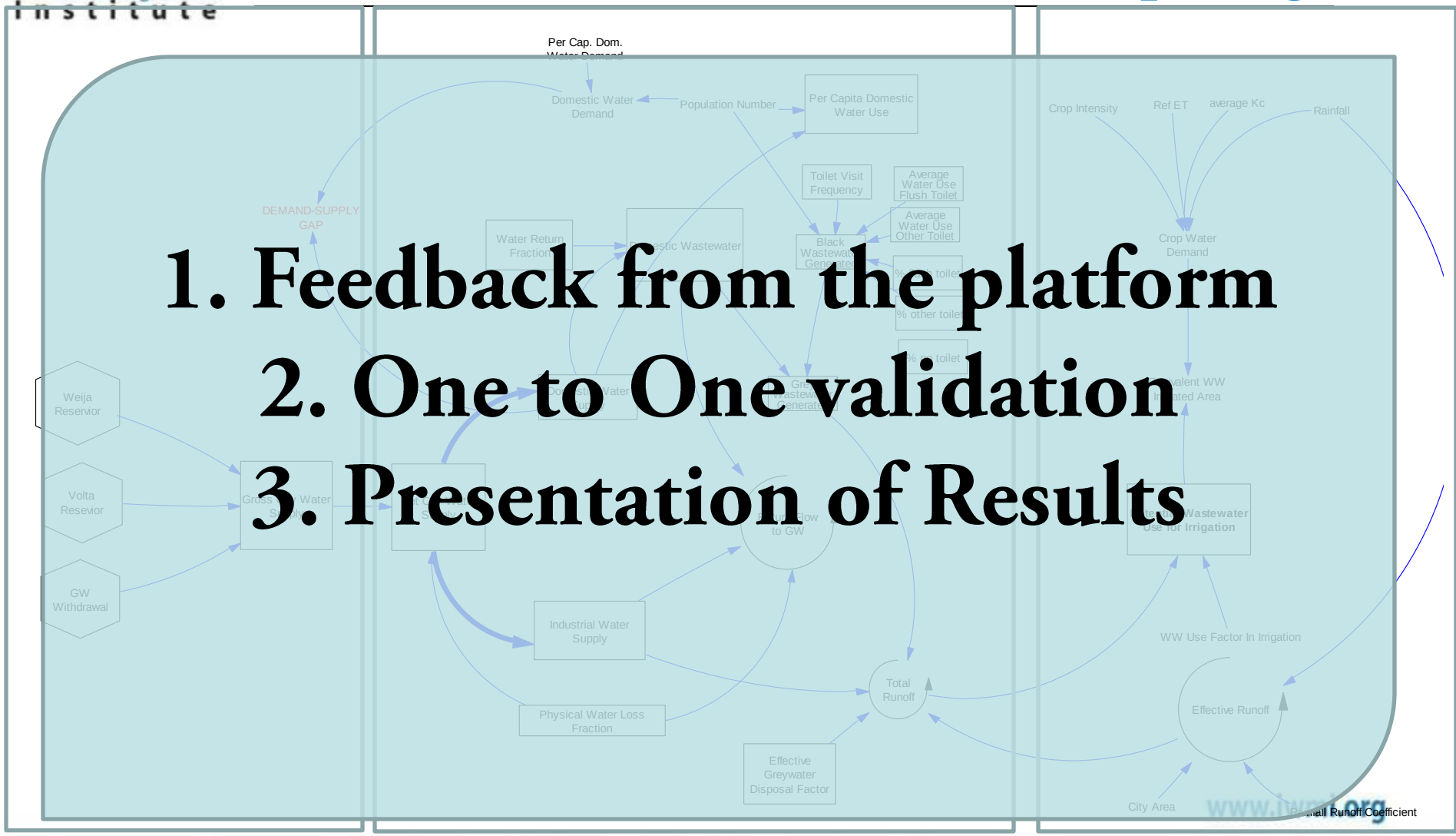
Water Supply	City Water Use	Waste Generation	Reuse in Agric.

Accra city water balance as used for the VENSIM model

Outputs for the modeling

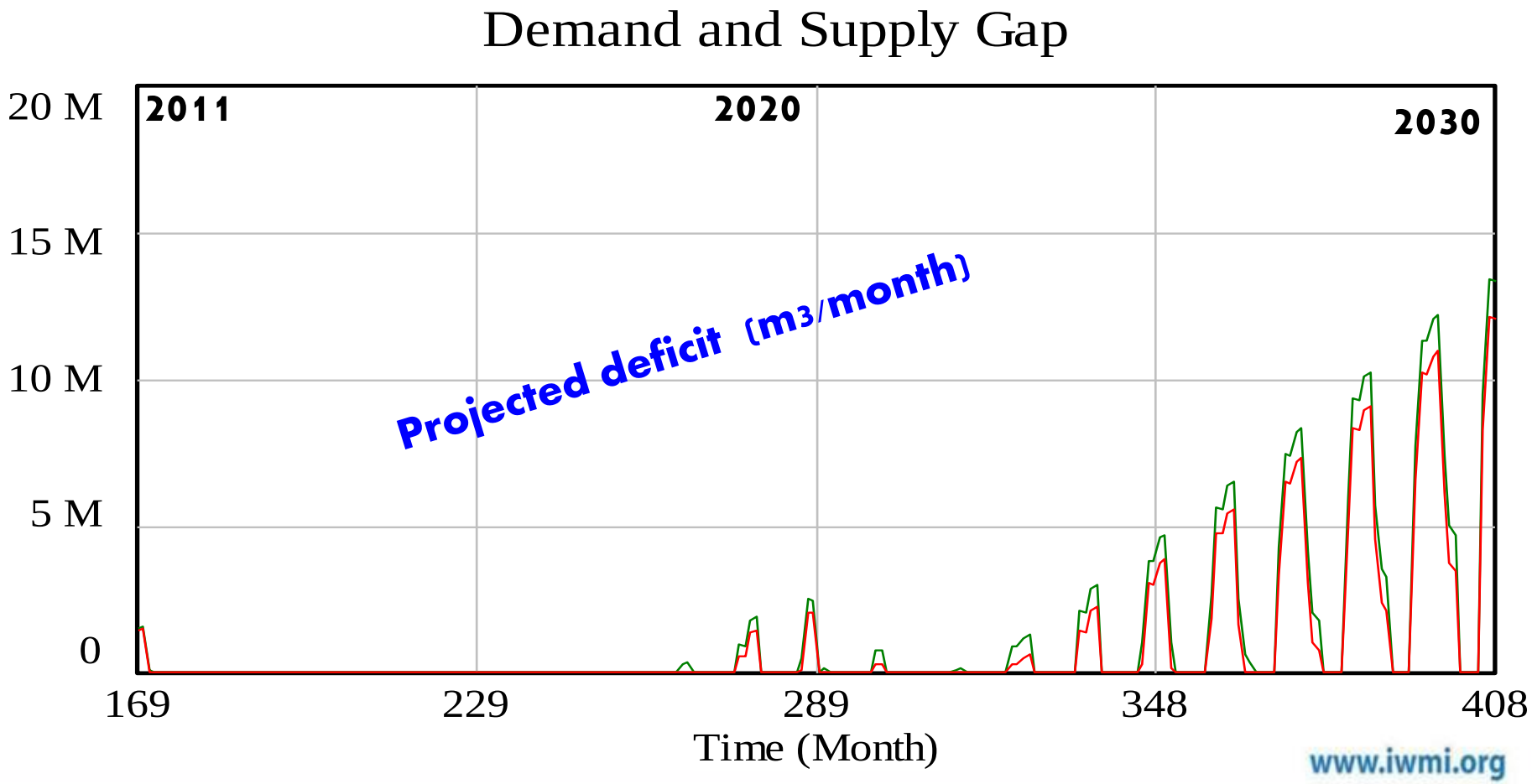
- Database
- Future Adaptation Scenarios (for water and wastewater management)
- Urban Water Model (decision support tool)

What is the model saying?



1. Feedback from the platform
2. One to One validation
3. Presentation of Results

Water Supply and demand of Addis Ababa City



Water Supply and demand of Addis Ababa City

Despite additional water supply development, by 2030 Addis will still have insufficient water supply due to increased temperature and expansion of population and wellbeing

- **Water saving and management compensates part of water demand and should be supported by policy and enforcing laws**
- **Water saving should include cocktails of measures**
  - **Water harvesting mechanisms**
  - **Using water saving facilities**
  - **Un-accounted water loss reduction**
- **Additional water supply source development**

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