Sixth Presentation of Session 1

Karen G. Villholth, Senior Researcher - Groundwater Management, IWMI, Pretoria, South Africa on **Challenges of Groundwater Management in Sri Lanka**

I have been working for IWMI for almost 5 years on two occasions. I was working here in Sri Lanka from 2004 to 2007 and it was during the tsunami in which I was very much involved. I think that was a very big eye opener for me as well as for other people regarding groundwater, generally speaking, in Sri Lanka. I also want to acknowledge counterparts, the WRB and the Eastern University; we worked together at the time. Knowing the conditions about the groundwater resources at such a disastrous situation was quite a critical time to understand what it takes to enhance the drinking water situation in the coastal line where salinity had increased with the tsunami. That was the major problem we faced.

I was going to talk about the challenges in managing groundwater. But I do not want to repeat what has already been said because we have already discussed many issues on challenges of management. The following areas would cover my presentation.

Groundwater resources of Sri Lanka.

Groundwater research and management development.

Comments on present progress.

Recommendations focusing on the management aspects.

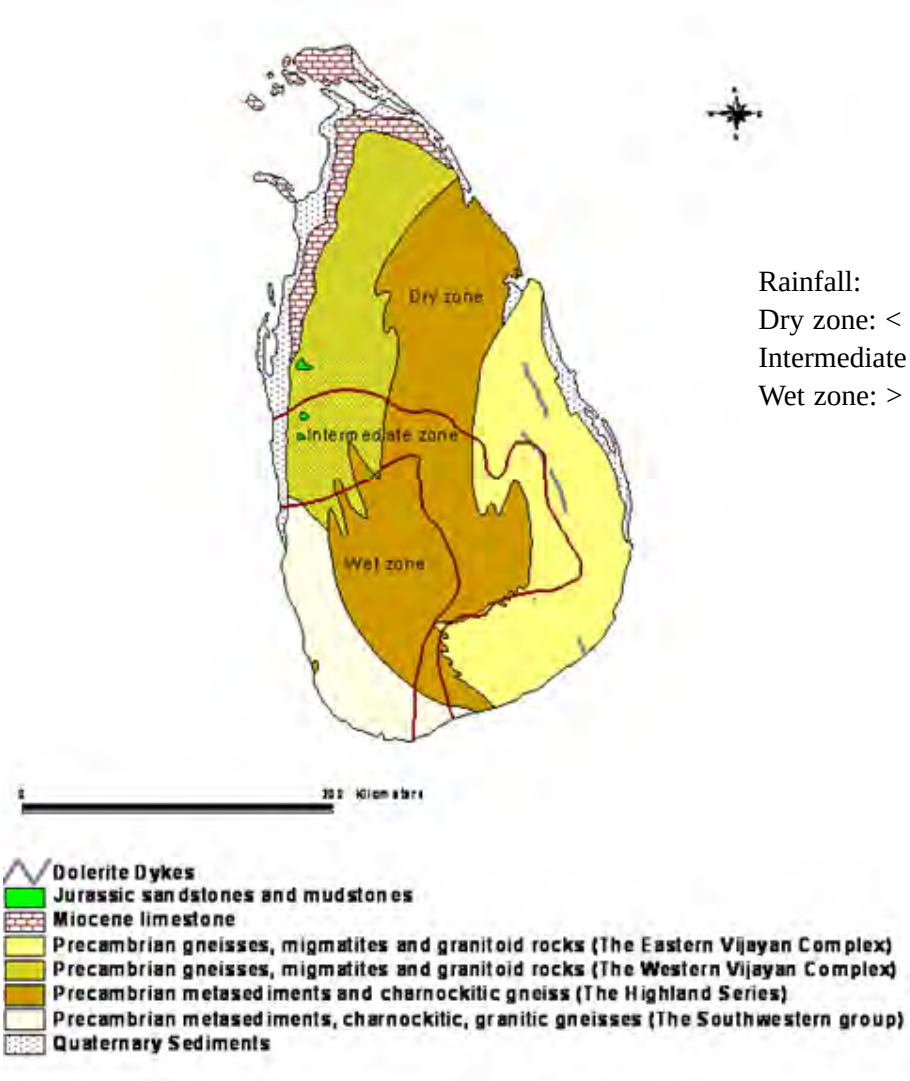
Major geological formations of Sri Lanka

Figure 11.6.1. below shows major geological formations of Sri Lanka.

Figure 11.6.2. below shows the five different aquifers in the country.

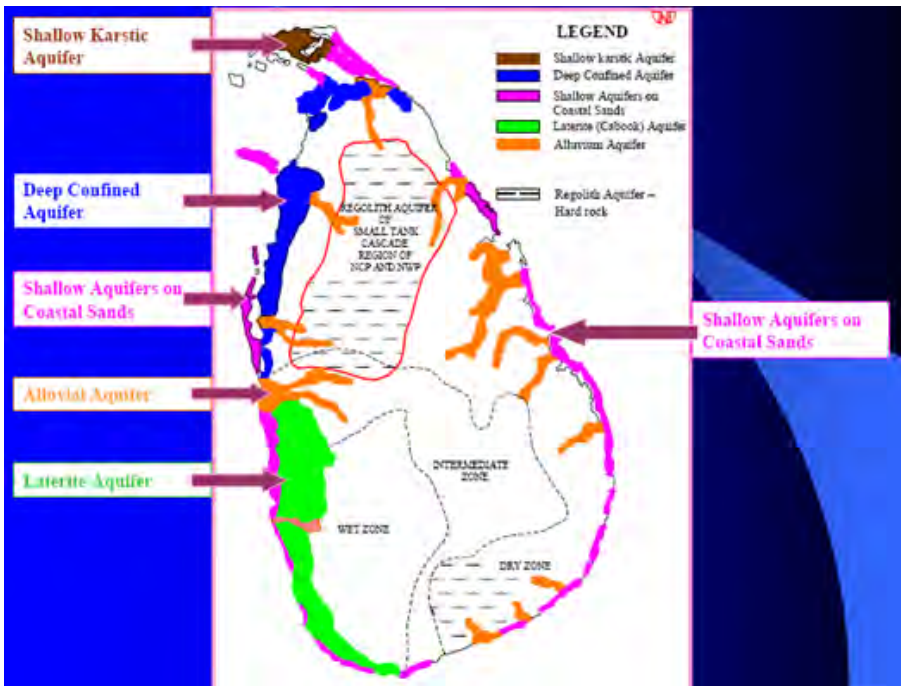
In Figure 11.6.3. the groundwater resources with geological conditions are superimposed with river basins in Sri Lanka. So you can see how these two overlap. There is not much good correspondence between where you have aquifer systems and where you have river basins. There is very low rainfall with poor aquifers in the dry zone and in the southern part and that is why it is running out of groundwater. Otherwise, Sri Lanka would probably be considered quite rich in groundwater resources. So that automatically gives some challenges in terms of managing groundwater. Because these are the two units you have to look at when you want to manage groundwater; you have to look at groundwater and surface water in combination.

In water management you have to look for optimizing these resources: where to use groundwater and where to use surface water. When you want to use groundwater well you have to look at surface water systems as these two have a very important interaction. That has to be looked into more in the future in terms of groundwater and overall water management in Sri Lanka.



Rainfall:
Dry zone: < 1,500 mm
Intermediate zone: 1,500 - 2,500 mm
Wet zone: > 2,500 mm

Figure 11.6.1. Major geological formation of Sri Lanka.



90% of area underlain by hard rock formations at shallow depth

Groundwater available: 7,250 million m^3/yr (Fernando 1985)

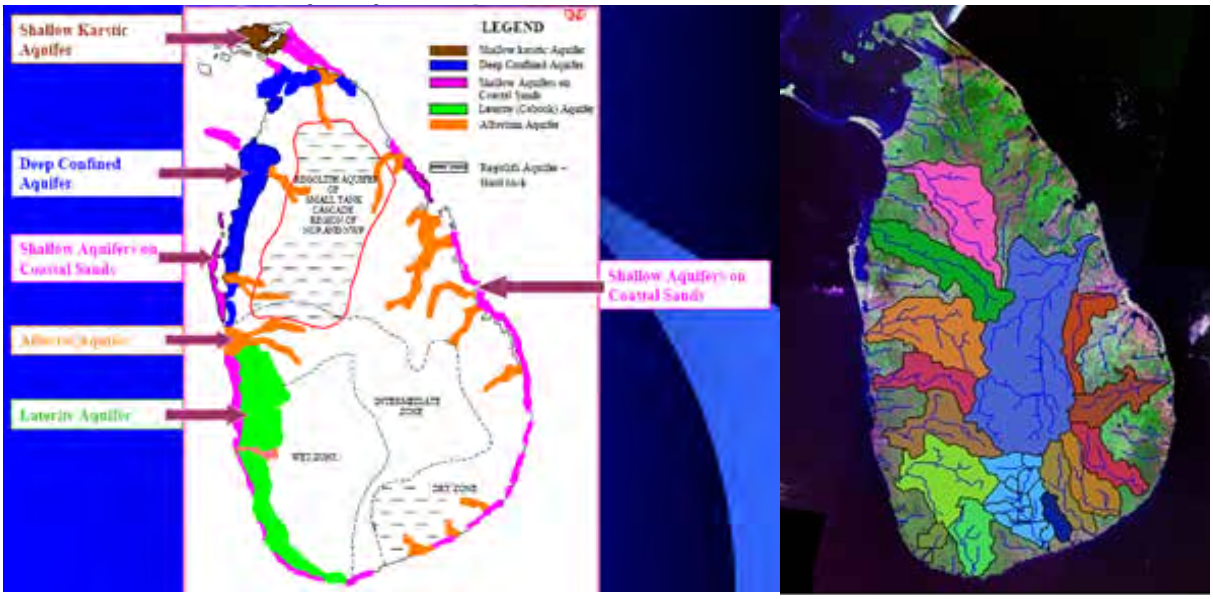


Figure 11.6.3. Surface vs. subsurface systems.

Groundwater is invisible

Groundwater is invisible; we cannot easily see and access it. We all know that. So that costs us a lot of challenges managing it. You have to dig into the groundwater to get data which cost us a lot. Also it is very costly to remedy any kind of damage caused to groundwater resources. And this is one of the fundamental problems in groundwater management.

Figure 11.6.4. Groundwater is present underneath.

Photo credit: Karen G. Villholth.

Threats to groundwater degradation are many

This one is closely related to the volume of groundwater. So over-extraction, leaking seawater, subsidance, failure of wells when the groundwater level drops and then you can see here all the sources of pollution. Manay of these are present here in Sri Lanka, and that is something we have to

pay attention to. In many cases, contamination problems are catching up with water quantity problems, and for groundwater this is very critical because it is very difficult to remedy it once it is polluted. So we have to see ways of prevention of groundwater pollution. We have to really protect this precious resource from the outset. If you do it later it would be costlier.

Figure 11.6.5. Groundwaer threats from groundwater use or decreasing storage.

Figure 11.6.6. Groundwater pollution threats.

Surface water and groundwater relationship

Surface water is an expression of groundwater

Also I have to tell you that surface water is a reflection of groundwater. We try to think of groundwater and surface water as two separate resources. But especially in Sri Lanka you have many river systems. Many of them are fed by groundwater. Part of the river flow is actually coming from groundwater. So if the groundwater is polluted surface water will be polluted. The above picture shows that flows of the rivers are very much reflections of the groundwater levels. So there is a very close relationship between groundwater and surface water. So you cannot separate the management of these two resources.

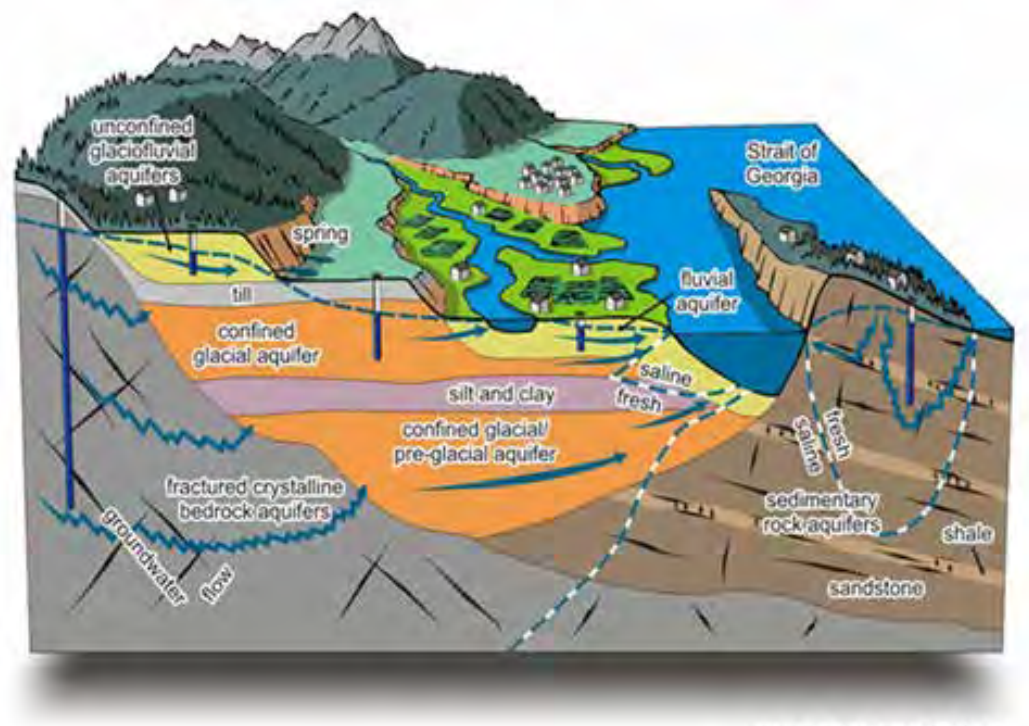


Figure 11.6.7. Surface water is an expression of groundwater.

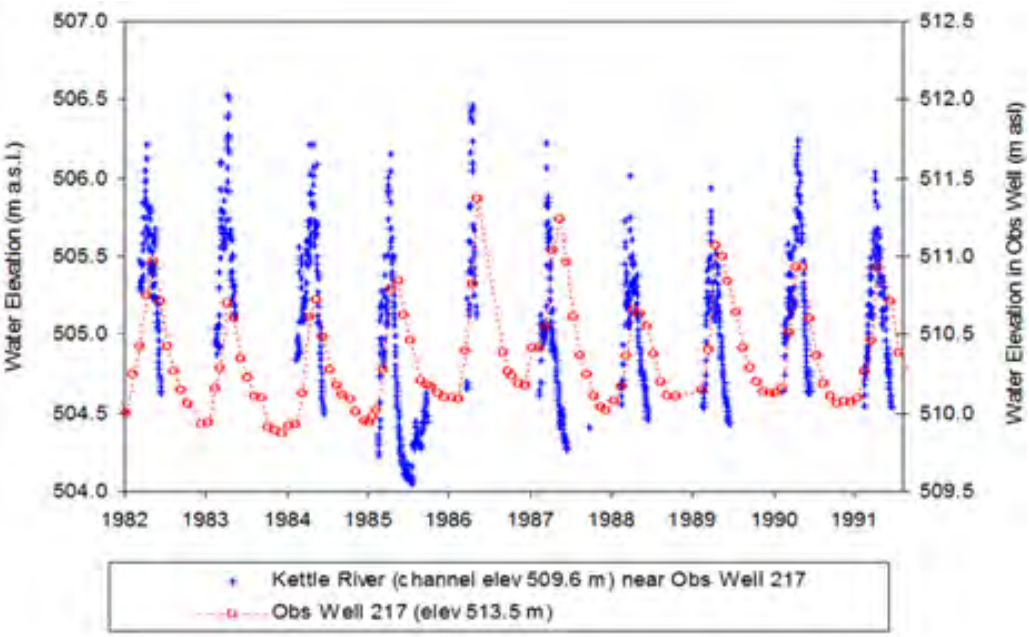


Figure 11.6.8. Surface water is an expression of groundwater.

Note: elev = elevation; Obs = observation.

Drivers for groundwater management

We have to do something about the first three figures out of the six given below because now we have problems. We also have long-term drivers: population growth, urbanization and food security imperatives that are more challenging. On top of that there are more incidental kind of problems so

that we have to address these situations facing us today.

ıre 11.6.10. Drought 2012.

Drivers for groundwater management

- Drought of 2012.
- Tsunami of 2004.
- Contamination incidences.
- Population growth.
- Urbanisation.
- Food security imperatives.

Figure 11.6.11. Population growth.

Photo credit: Karen G. Villholth.

IWMI involvement in groundwater research in Sri Lanka

- Groundwater conditions in Sri Lanka (Panabokke, WRB 2007) – some early works.
- Agro-wells in the dry zone Kikuchi et al. 1996.
- Coastal sand and limestone aquifers in Jaffna and Kalpitya.
- Tsunami impacts on the east coast.

Conclusion in early 2007

- “Groundwater management in Sri Lanka is in its early stages”

When I did some assessment of management of groundwater resources in 2007 my conclusion was that groundwater management was in its infant stages. And when I was requested to make this kind

Figure 11.6.12. Laborataries.

Photo credit: Karen G. Villholth.

We heard from the previous speaker that a lot of work is being done under the DSWRPP and they are introducing new laboratories. They are doing a lot of awareness-raising on groundwater and they are setting up a big monitoring system in the country, trying to understand resources and going forward on the basis of knowledge and doing it in a systematic way and trying to understand critical areas where groundwater is used and where there is a lot of human pollution. We are happy to see all these developments. And also we see increased applications of groundwater modeling systems in trying to understand this resource and we see a lot of dialogue between the institutions involved in groundwater management. I think this is really the breaking point; that is trying to get all the institutions together to see problems, how we can collaborate to take this forward. I think this is something very critical.

Figure 11.6.13. Conducting awareness-raising programs.

Photo credit: Karen G. Villholth.

Groundwater monitoring

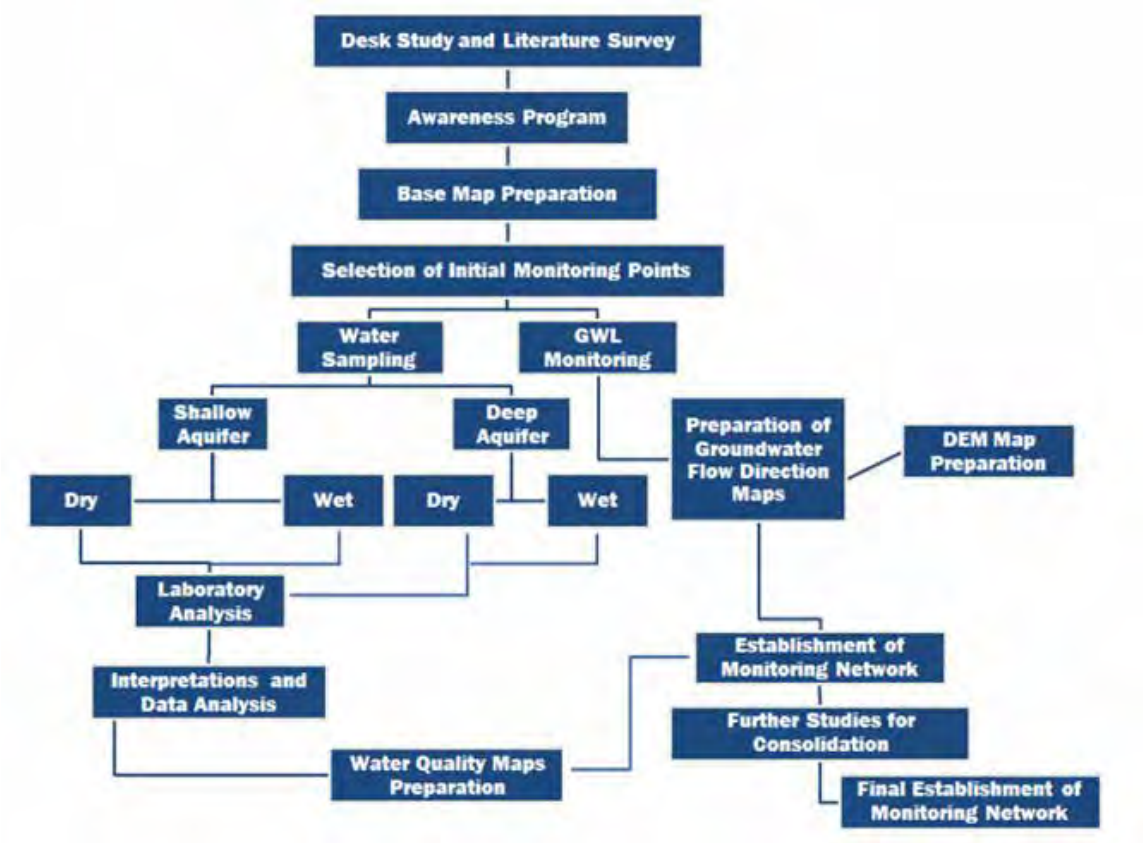


Figure 11.6.14. Flow chart for groundwater monitoring process.

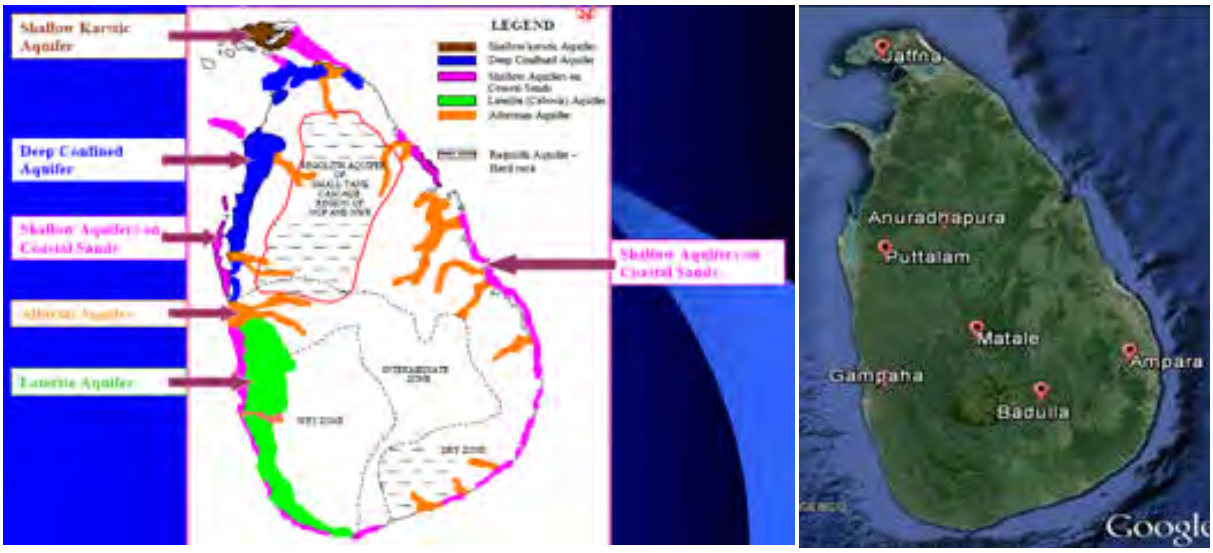


Figure 11.6.15. Map showing pilot sites selected for monitoring.

Table 11.6.1. Surface water and groundwater in various districts.

District	Total supply of SW and GW resources (m^3/day)	Supply of GW resources (m^3/day)	Percentage of GW supply (%)	Percentage of SW supply (%)
1.Ampara	12,457.0	329.0	2.6	97.4
2.Anuradhapura	20,965.0	3,285.0	15.7	84.3
3.Badulla	22,223.0	0.0	0.0	100.0
4.Baticaloa	1,449.0	1,449.0	100.0	0.0
5.Colombo	561,889.0	0.0	0.0	100.0
6.Galle	26,247.0	987.0	3.8	96.2
7.Gampaha	51,374.0	4,859.0	9.4	90.6
8.Hambanthota	27,176.0	1,021.0	3.8	96.2
9.Jaffna	209.0	209.0	100.0	0.0
10.Kegalle	15,887.0	0.0	0.0	100.0
11.Kaluthara	30,604.0	555.0	1.8	98.2
12.Kandy	44,075.0	13,233.0	30.0	70.0
13.Kurunegala	11,483.0	1,800.0	15.6	84.4
14.Mannar	550.0	550.0	100.0	0.0
15.Monaragala	4,228.0	12.0	0.3	99.7
16.Matale	13,113.0	714.0	5.4	94.6
17.Matara	77,482.0	1,311.0	1.7	98.3
18.Nuwaraeliya	8,724.0	4,500.0	51.6	48.4
19.Polonnaruwa	7,655.0	355.0	4.6	95.4
20.Puttlam	8 694.0	8,424.0	96.8	3.2
21.Rathnapura	19 650.0	0.0	0.0	100.0
22.Trincomalle	1 433.0	9.0	0.6	99.4
23.Vavuniya	776.0	776.0	100.0	0.0

Note: SW = surface water; GW = Groundwater.
Groundwater use for water supply
Increasing model applications

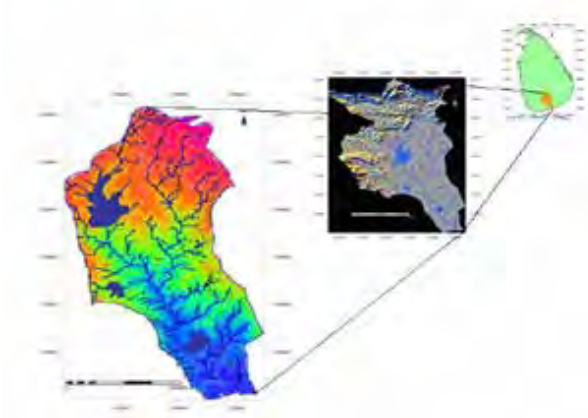
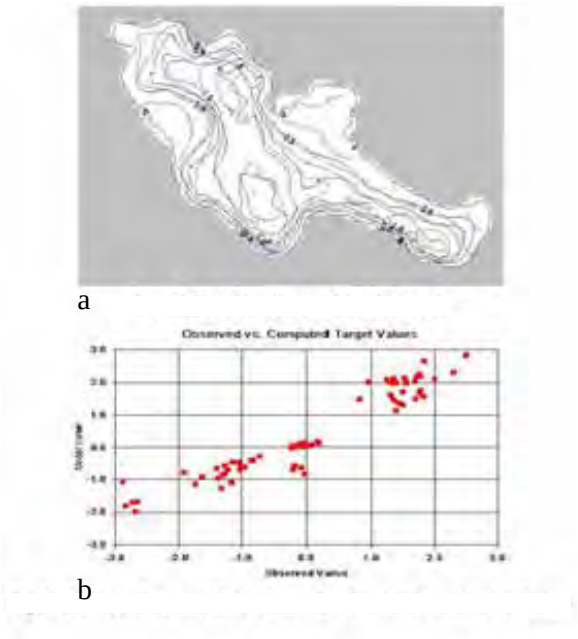


Figure 11.6.16. Walawa.



Figures 11.6.17 a and b. Kayts.

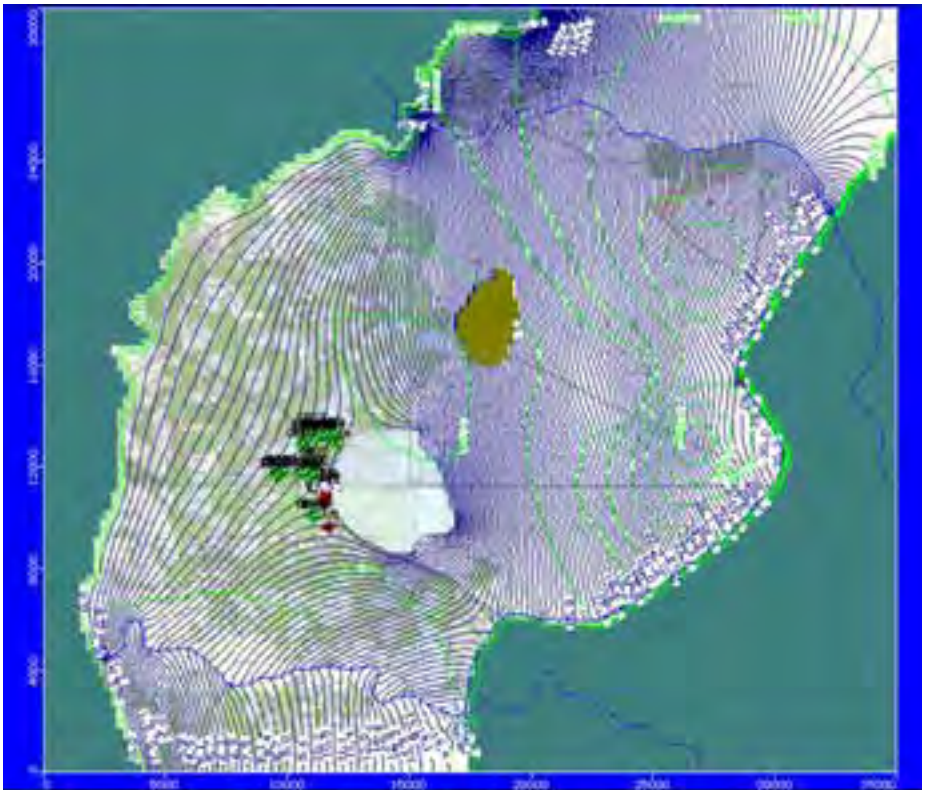


Figure 11.6.18. Mannar.

Figure 11.6.19. Increasing dialogue by having meetings.

Photo credit: Karen G. Villholth.

Pillars of groundwater management

We have to build a very fundamental knowledge base on groundwater conditions. We need to know the users as well as the institutions that are trying to manage this resource. This is the very basis of groundwater management. Once you have the knowledge you go on getting more knowledge. You try to control what is related to groundwater abstractions, pollutions as well as the land use. I think the last one is important to keep in mind. It is not like surface water. It is basically what happens to that water. Groundwater is very much related to what is going on in the ground; so it is very important.

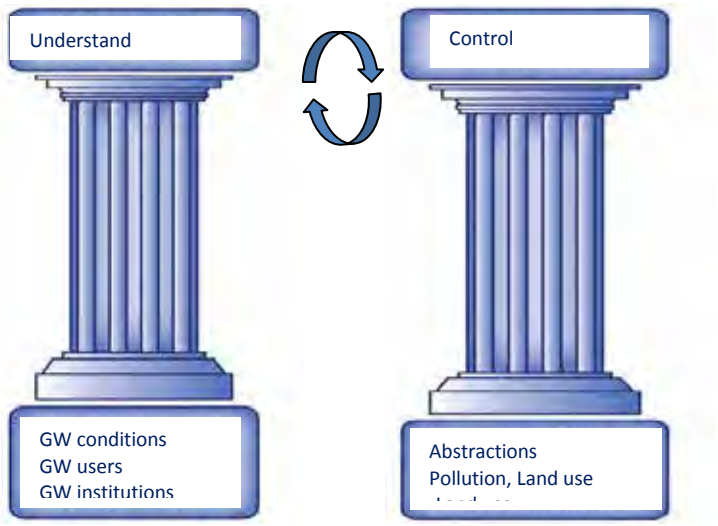


Figure 11.6.20. Pillars of groundwater management.

Note: GW = Groundwater.

Table 11.6.2. Special considerations/provisions needed in aquifer management

Groundwater distinct characteristic	Joint user/use registration, regulation, monitoring, and enforcement	Prior notification of development plans to other party	Precautionary principle	Conflict resolution	Stakeholder engagement	Long-term monitoring of resource	Flexibility in conceptual model and clear data sharing arrangements	Land use and waste regulations	Prioritized protection
Open source	xx								
Invisible and heterogeneous		x					x		
Vulnerable to land use impacts									
Slow reacting/delay in response		x							
Recharge/discharge is distributed and uneven									
Boundaries uncertain							xx		
Climate change impacts uncertain							xx		
Blurred up- and down-stream relations							xx		

Relationship between groundwater properties and what that means to groundwater management

Basically, groundwater has specific properties like groundwater vulnerability. We have to use precautionary principles.

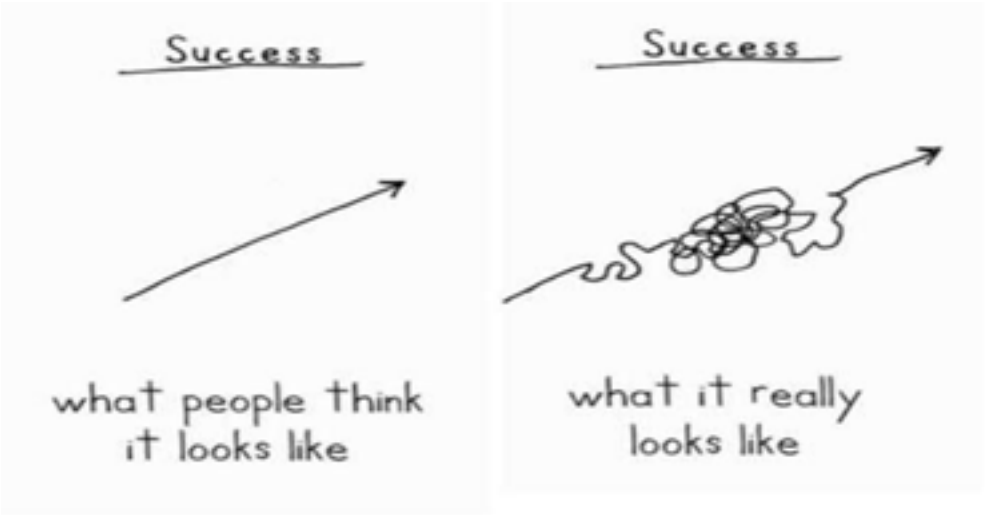


Figure 11.5.21. Success in groundwater management.

Groundwater management is not a straight line and it is a composite process that will take a long time to get a good system and we have to keep trying and go forward.

Research needs

- Monitoring should be coupled with better conceptual understanding of flow and transport processes and chemical processes in the aquifer systems.
- Understand the socioeconomic implications of groundwater use and threats.
- Understand the recharge mechanisms, recharge levels and impacts of climate change.
- Monitoring to include groundwater abstractions (not being done at the moment).
- Understand groundwater resources and groundwater installation failure (need to know whether it is failure of groundwater or of pumps).

Management needs

- Policies and regulations to be formulated explicitly.
- Roles and responsibilities of various groundwater-related organizations to be clarified and coordinated.
- Integrate groundwater management with environmental protection.
- We have to intensify research.
- Supplant IWRM with various nexuses:
    - Water(ground) – food.
    - Water(ground) – energy.
    - Water(ground) – waste/sanitation/urban growth.
    - Water (ground)– land use.
    - Water(ground) – climate change.

Incentive researchers needed

- Increase funding for earmarked groundwater research.
- Implement awards for best groundwater research.
- Collaborate internationally.

Private sector

- Coorporate social and environmental responsibility.
- Green economy.
- Awards to green producers.

Conclusions

- We cannot afford to lose any aquifers because of groundwater degradation – simply too costly and it has too many implications in the long term so we have to protect and prevent any major problems.
- Groundwater management in Sri Lanka has received increased attention and resources over the last decade.
- Explicit policies and regulations are still lagging behind, with unclear mandates for various constituencies of the public sector – we are still lagging behind.
- Increasing dialogue and partnerships for research and management on groundwater issues that are developing.
- The knowledge base for groundwater management is increasing.
- Recommend to establish an ad-hoc national-level interdisciplinary working group on groundwater management under the aegis of the WRB and try to define the roles of each agency.

I think that is what I wanted to say. Thank you very much.

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