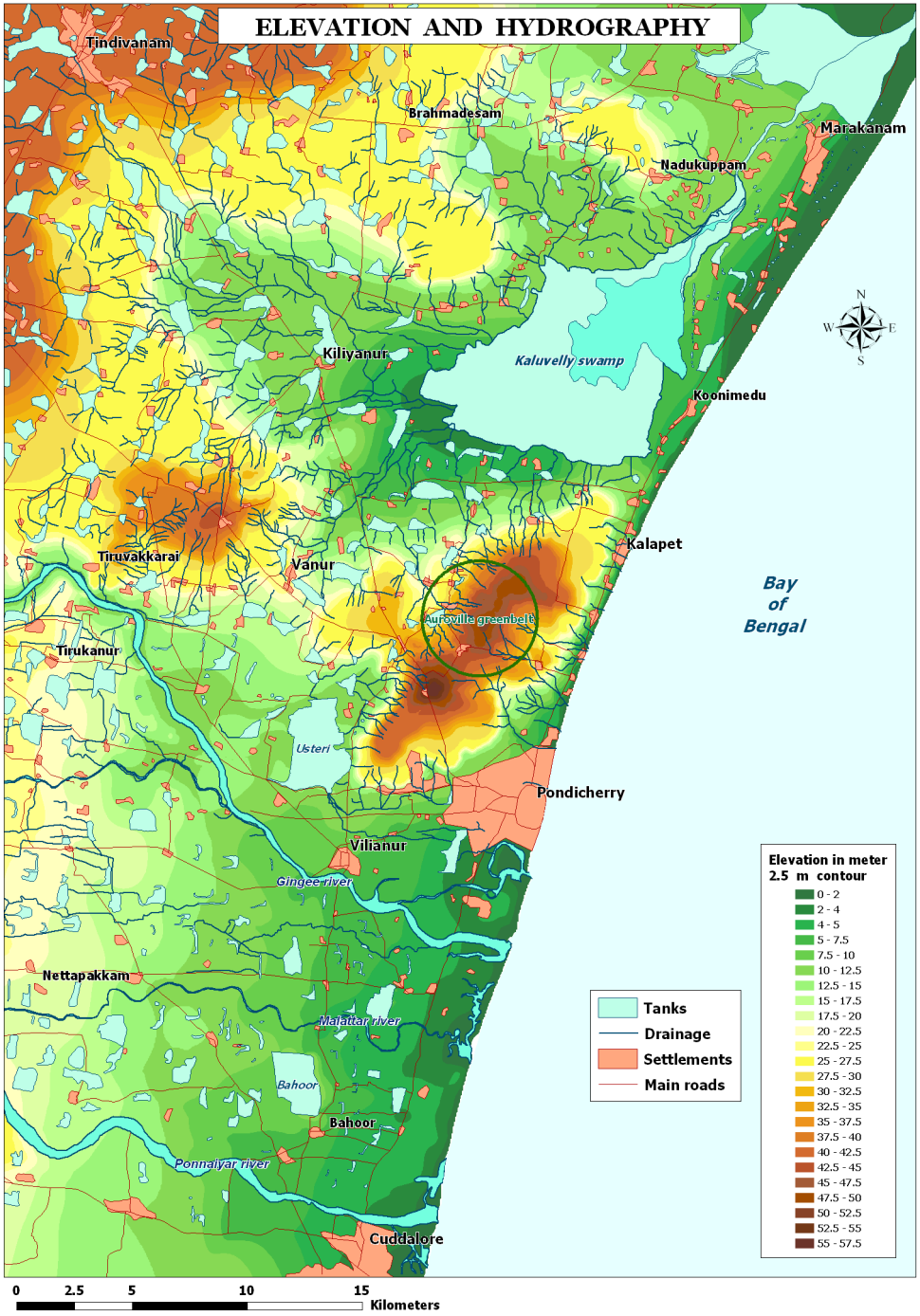


Auroville

Toward Water Security

Taking Stock & Plan of Action

March 2019

L'Avenir d'Auroville

Water management

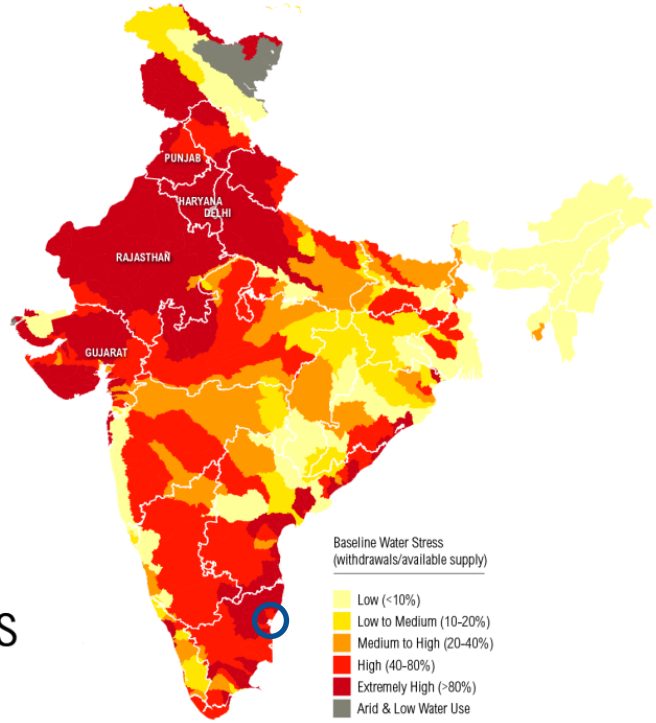
Core issues

- Auroville is facing a crisis in regard to water security
  - WHY? Depletion and Degradation of water resources at Regional Scale
  - ➢ Are we ready? NO!
- Ground water alone cannot ensure water access
- Way Forward: to implement a sustainable water management based on
  1. **Water Governance** for a sustainable, informed, socially integrated society
  2. **Monitoring of resources, consumption & quality**, open source
  3. **Multi-sourcing, with rainwater as the main resource,** scalable
  4. **Optimized supply networks,** reliable accessibility
  5. **Treatment & Recycling of wastewater,** first for greenery then in-house
  6. **Optimization of Water consumption,** metering, saving devices, training of planners & developers, public awareness, open source
  7. **Capacity building for O&M,** training, pear to pear
  8. **Diversification of funding opportunity, Development of Self financing capacity**
  9. **Dissemination** towards local population, government and international agencies

General Context

Water Stress in India

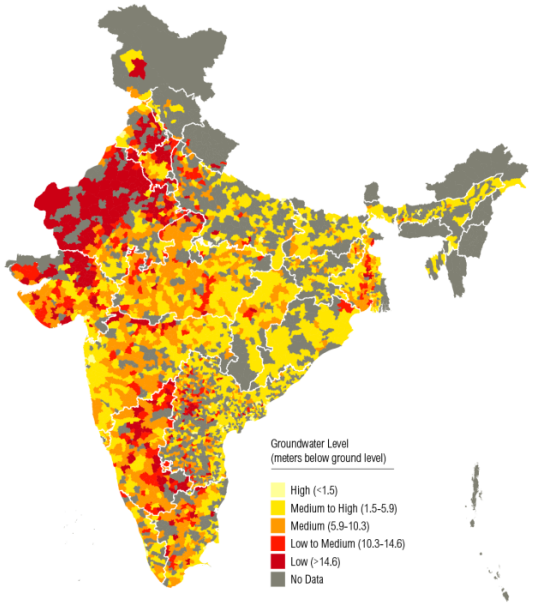
54% of India Faces **High** to **Extremely High** Water Stress



URBANIZATION

- About 30% of Indian population lives in cities
- Urban population will double by 2050.
- More than 100 Indian cities ≥ 10 lakhs people by 2030

54% of India's Ground-water Wells Are Decreasing



Regional Context

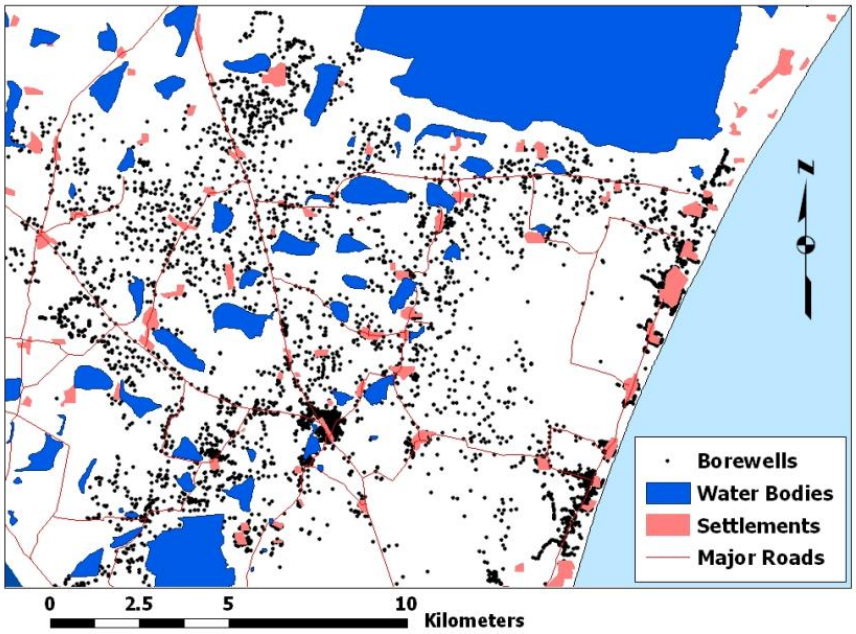
Ground water over exploitation- Exponential development of wells

Wells Development through time in Auroville Area

(Ref: Auroville Water Harvest -2006)

Total Number of Wells Surveyed : 6137 on 250sq km

Number of Wells in Auroville: 247



Overexploitation of Ground Water

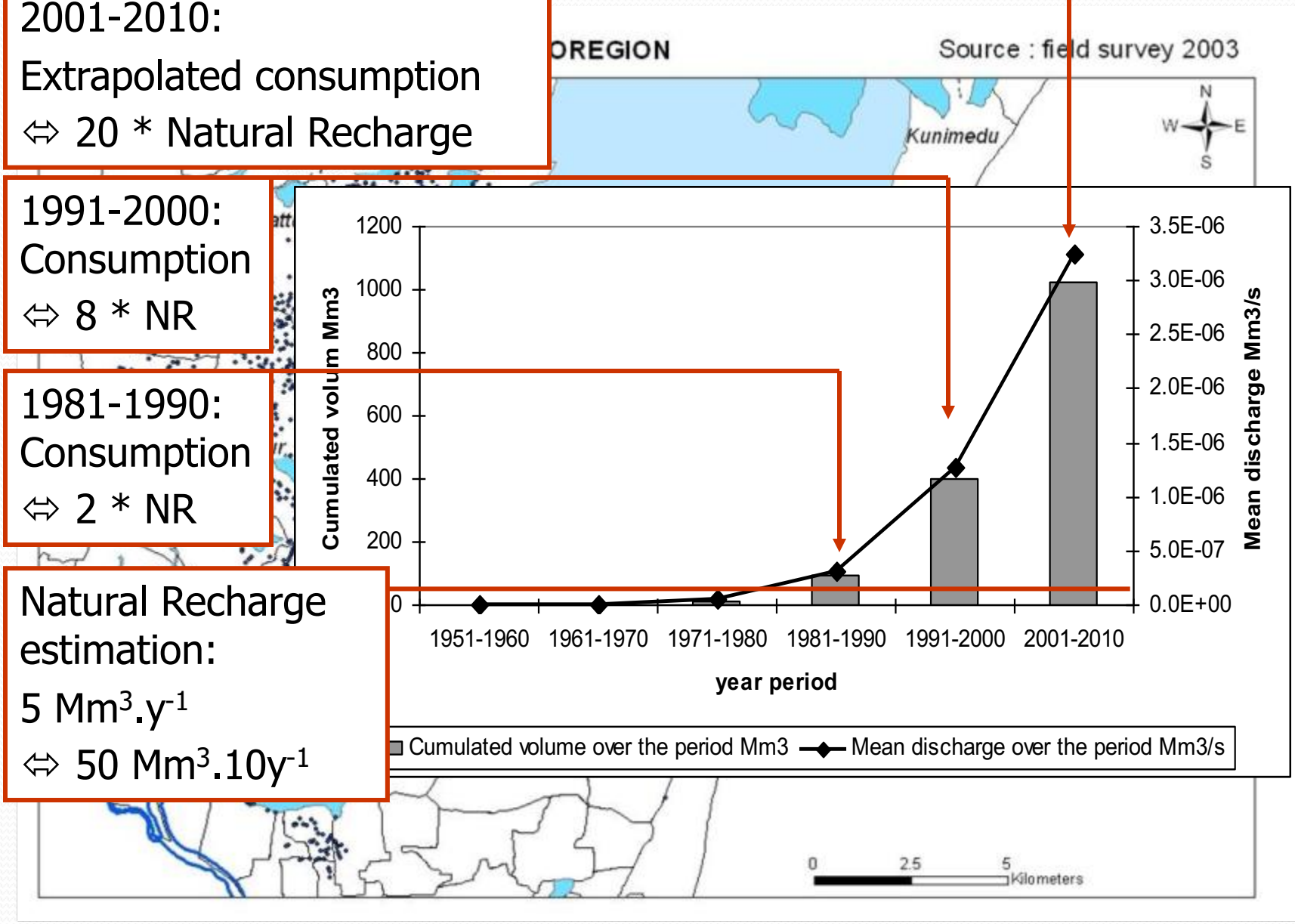
Hydrogeology: Evolution of Extraction on Vanur Aquifer

2001-2010:
Extrapolated consumption
⇔ 20 * Natural Recharge

1991-2000:
Consumption
⇔ 8 * NR

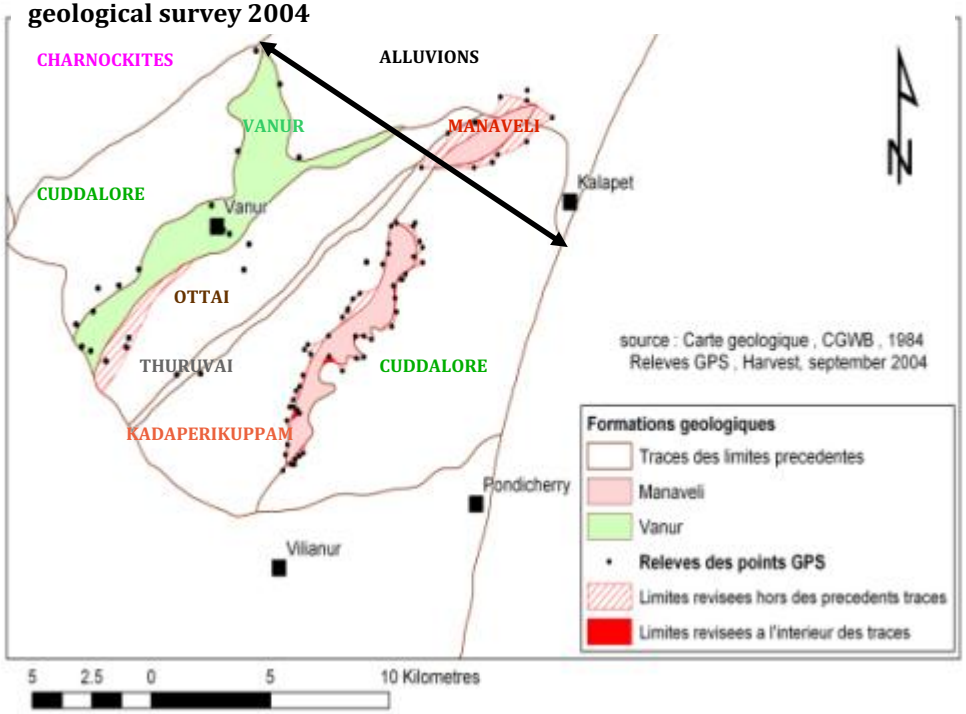
1981-1990:
Consumption
⇔ 2 * NR

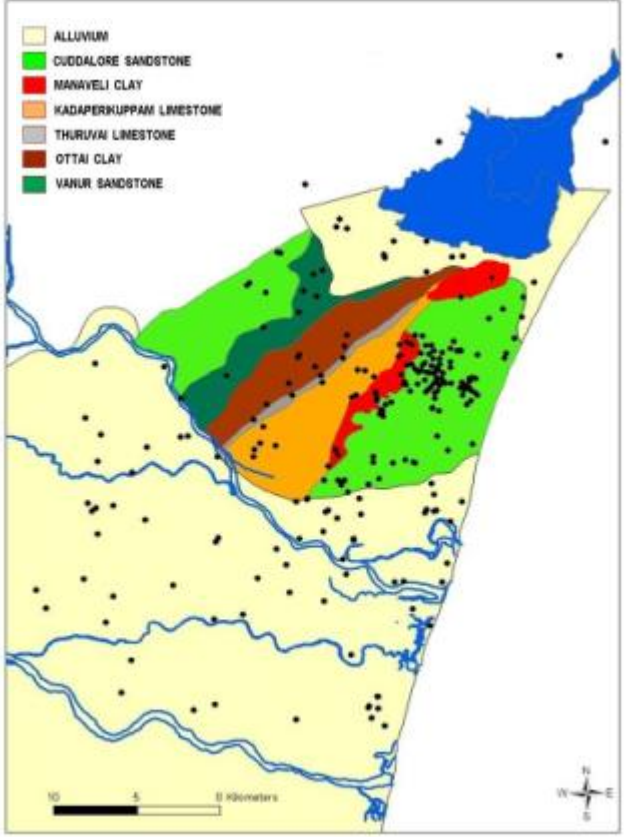
Natural Recharge estimation:
5 $Mm^3.y^{-1}$
⇔ 50 $Mm^3.10y^{-1}$

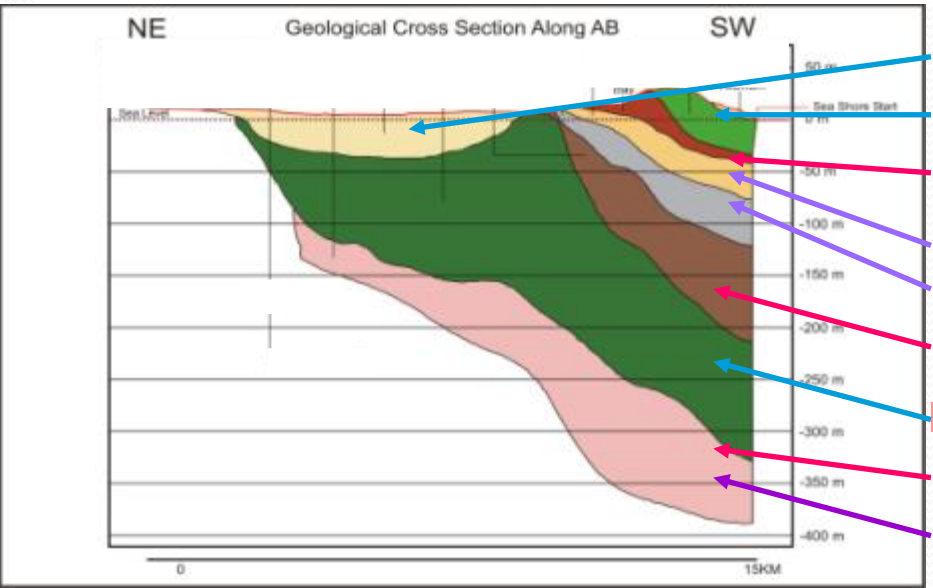


Groundwater Flow Modelling

GEOLOGICAL MAP CGWB 1984 AND MODIFICATIONS after detailed geological survey 2004

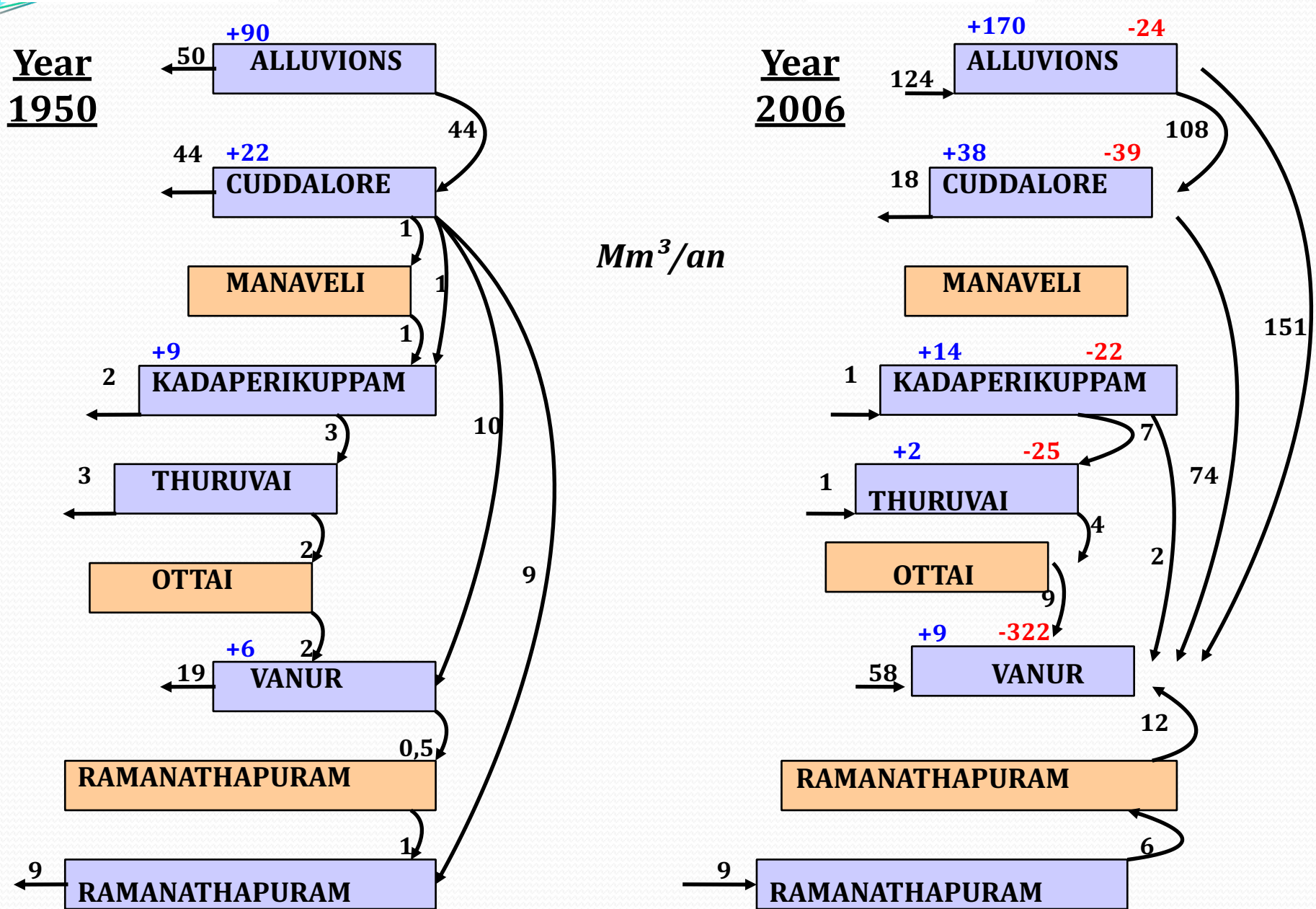






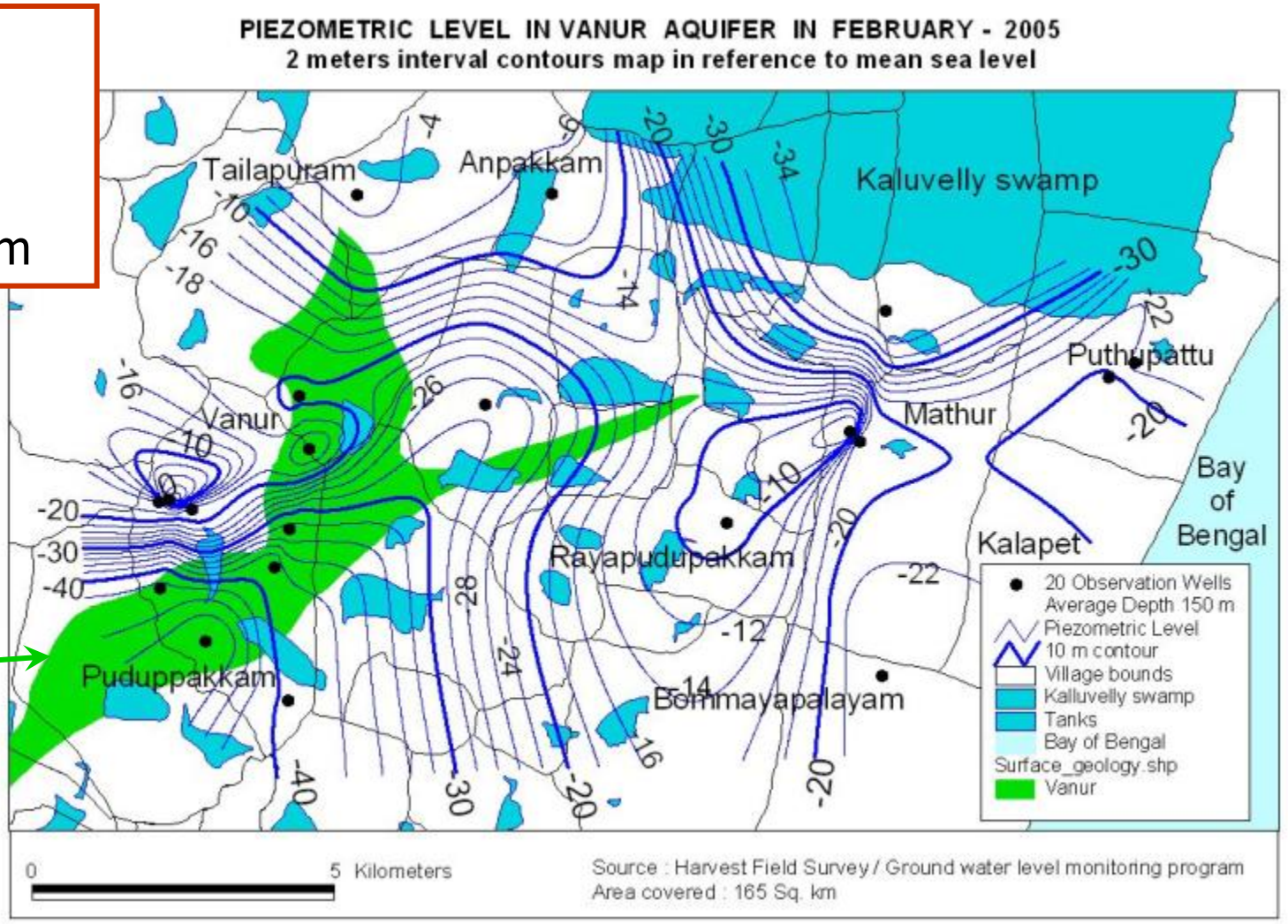
ALLUVIUMS	ALLUVIONS GOOD PROPERTIES
CUDDALORE SANDSTONES	AQUIFER GOOD PROPERTIES
MANAVELI CLAY	AQUITARD
KADAPERIKUPPAM CALCAROUS	AQUIFER MINOR IMPORTANCE
THURUVA CALCAROUS	AQUIFER MINOR IMPORTANCE
OTTAI CLAY	AQUTARD
VANUR SANDSTONES	AQUIFER GOOD PROPERTIES
RAMANATHAPURAM CLAY	AQUITARD
RAMANATHAPURAM SANDSTONES	AQUIFER SULPHATE-RICH

Groundwater Flow Modelling - WATER BALANCE



Hydrogeology - Vanur aquifer, main aquifer of the area

water level
1975: +7 m msl
2005: -47 m msl
= drawdown ~54 m



Vanur outcrop area

❁ Piezometric map: over exploitation of ground water

Hydrogeology - Vanur Aquifer

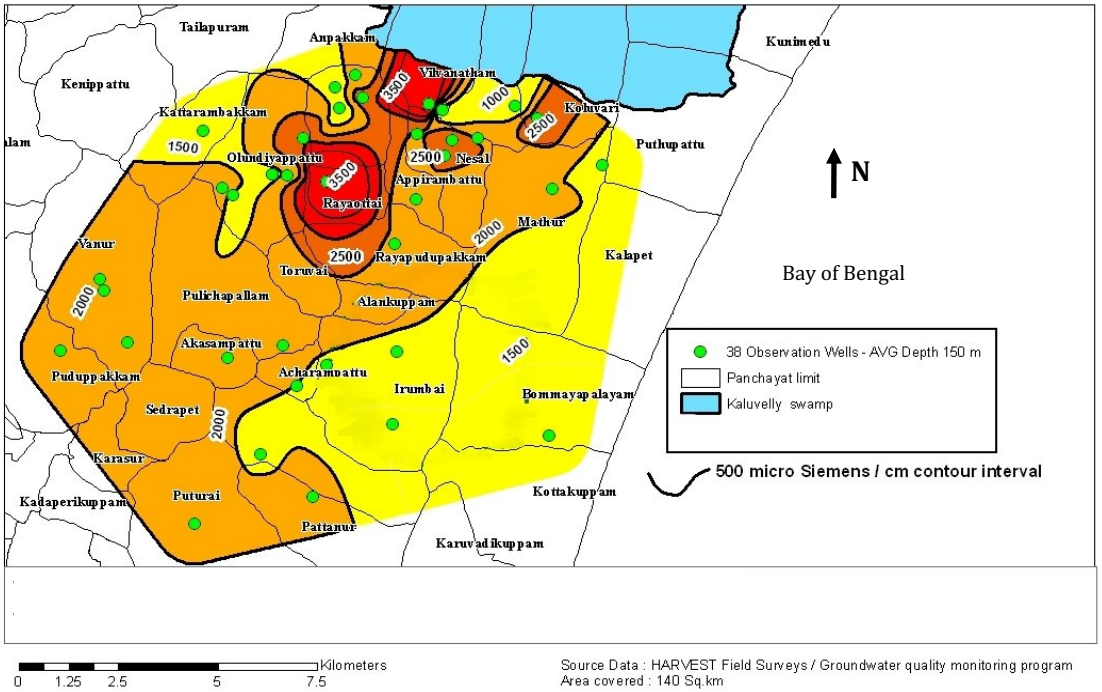
Aquifer mineralization

High mineralization recorded since 1996

red areas > 3 g/L (3,000 µS/cm)

Standard threshold values from WHO

- drinkable water 1 g/L (1,000 µS/cm)
- irrigation ~1.5 g/L (1,500 µS/cm)



Geochemical study 1999-2003 of 250 km^2 of the northern part of the sedimentary basin *d'Ozouville et al., 2006, Paris 6 University, Tours University, Rennes University, IPGP*

Source of Salinity till 2007:

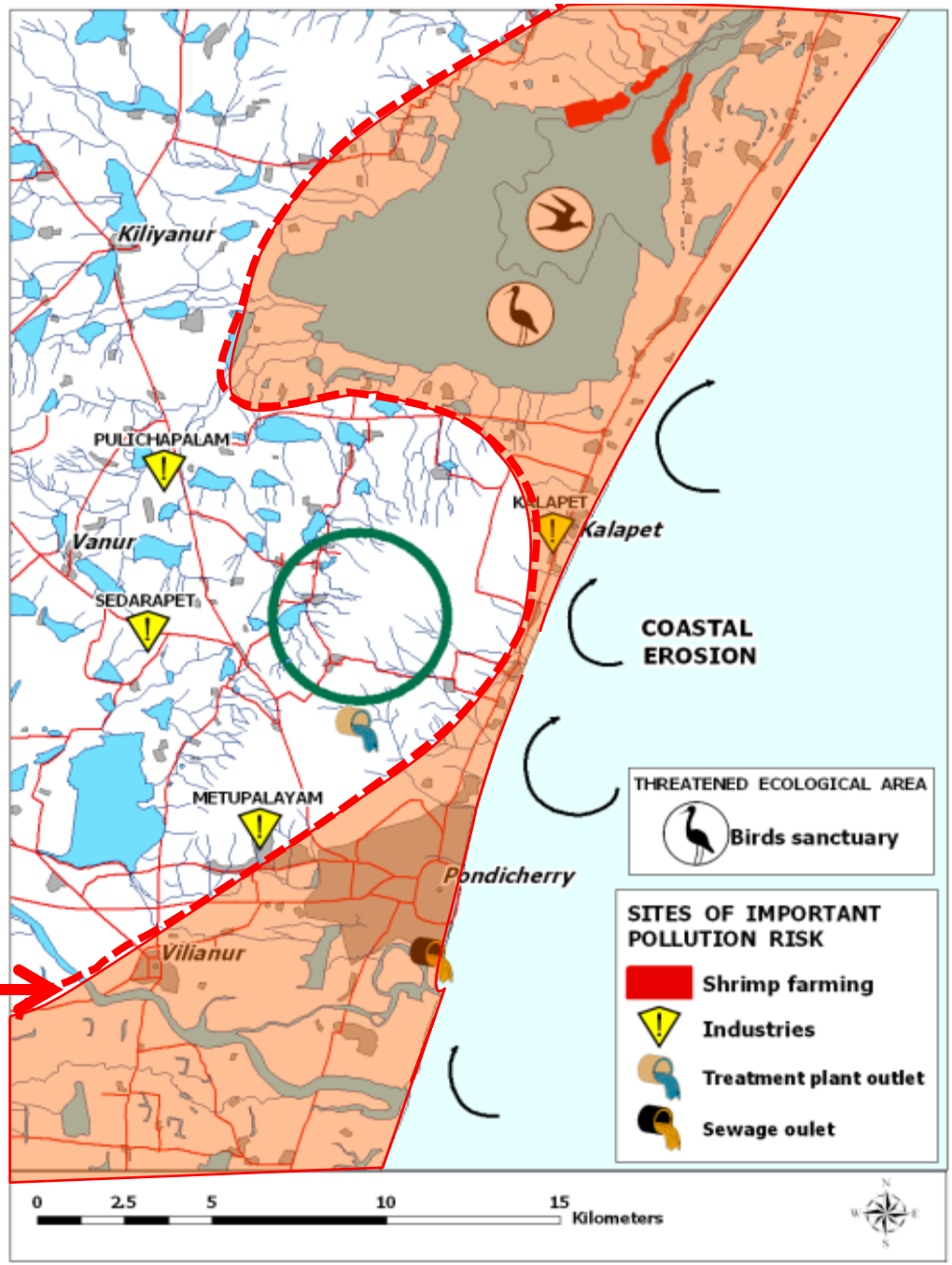
- Upward leakage of sulphate-rich water coming from the Ramanathapuram aquifer due to water level depression in the Vanur aquifer
- Brackish water coming from Kaluvelli swamp
- Human activities like fertilizers accumulation and irrigation return flow

Environmental Degradation

Main issues

- Over exploitation of ground water
- Reduced recharge
- Absence of management of water resources
- Contamination of ground water by seawater intrusion
- Poor Regulation

Approximate limit of Seawater Intrusion



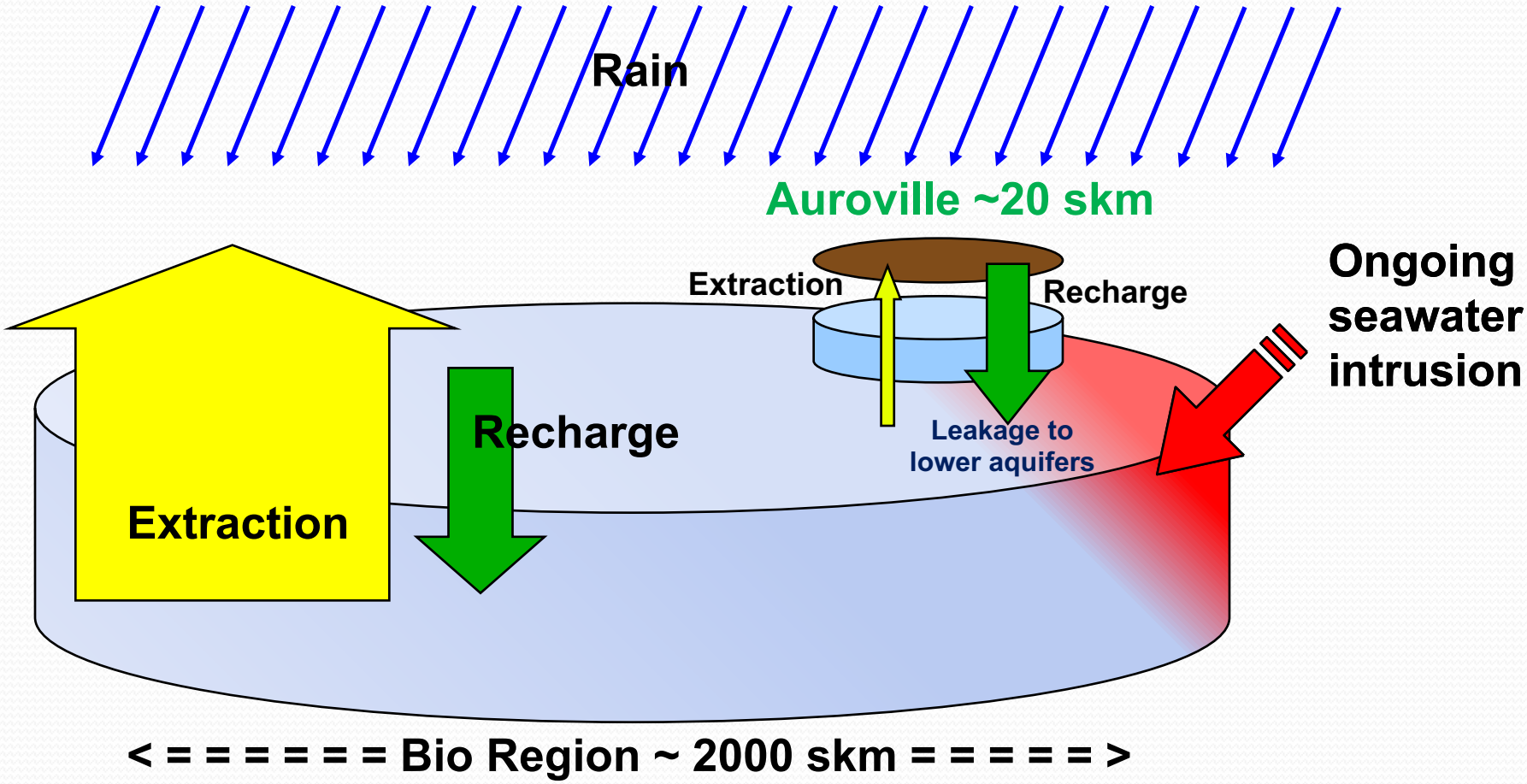
But Also

- Prowling urbanisation
- Infrastructure development
- Non-Source Pollution
- Solid waste disposal
- Lack of sanitation facilities
- Fragilized eco-system

…

Auroville Context

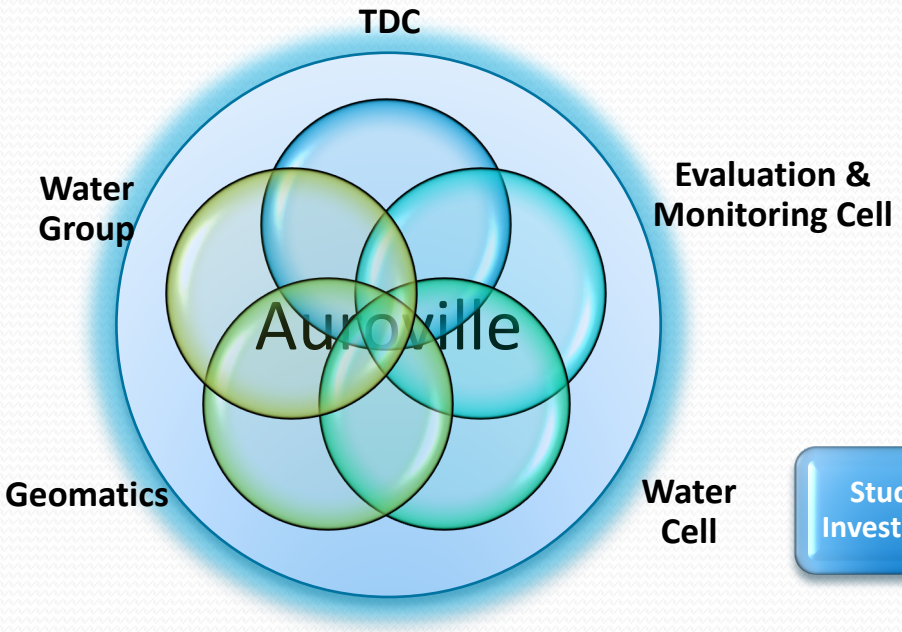
Water Security cannot be achieved through ground water alone



Taking Stock

Water Management Organisation - L'Avenir d'Auroville

Management



Service providers

Studies & Investigations

- Agencies &individuals in and out of Auroville
- Research organisations
- Government agencies

Implementation O&M

- **Pour Tous Water** : Maintenance & Repair
- **Water Service** : O&M of supply systems
- **Road Service** : Earth work, installation of sewer and supply systems.
- **CSR** : design and provide solutions for STP and water storage

Other implementing and O&M agencies

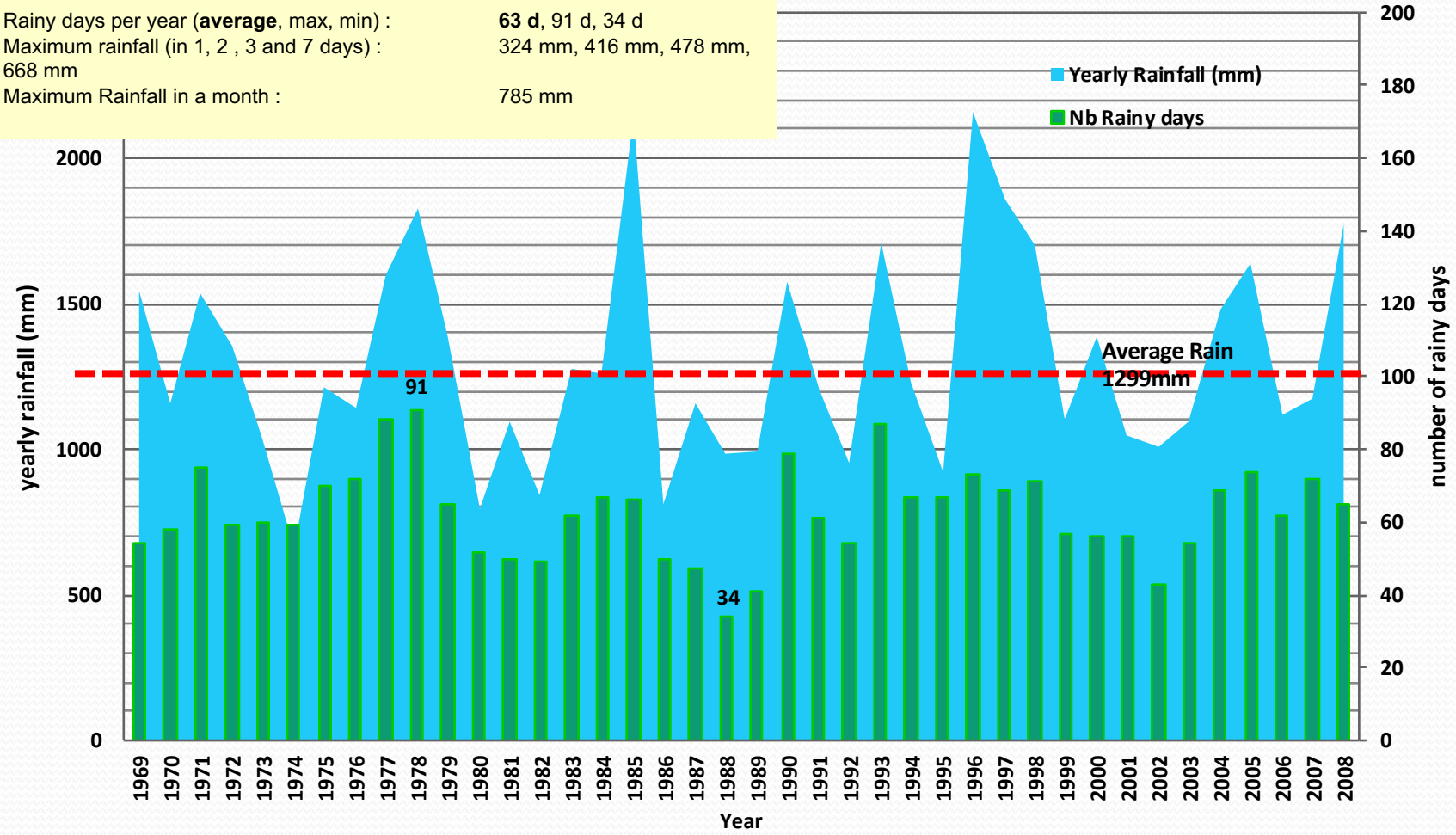
- AuroMira
- Aquadyn
- Selvam – Multipurpose Unit
- Alok from Industrial Zone
- Auzolan:
- Georgio (Water filter expert)
- Auromodele – Service Group
- Outside agencies

Rain

Yearly rainfall in Auroville area

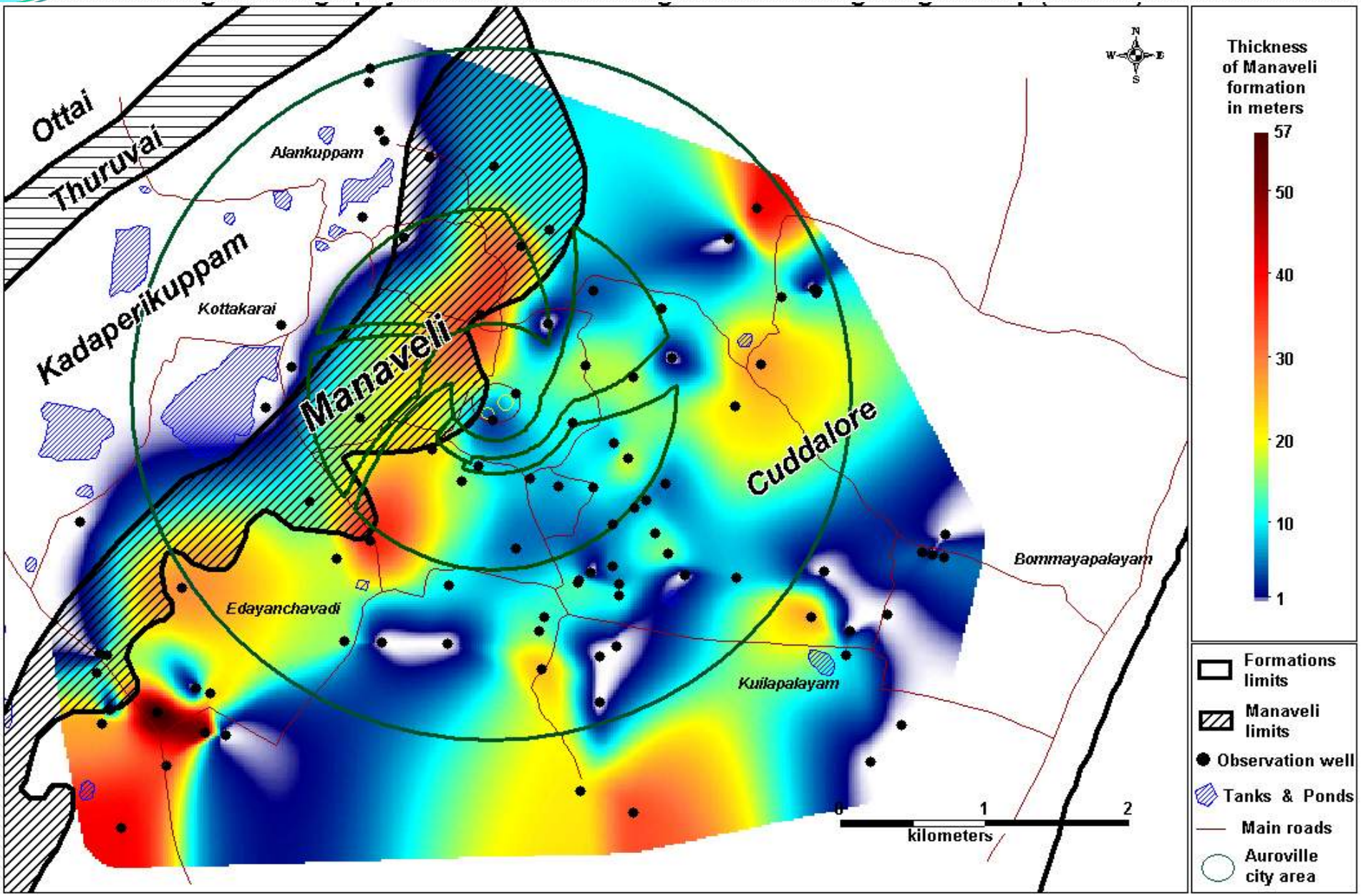
Source : Daily Rainfall in Pondicherry Meteo Station, Pondicherry Airport + Auroville Harvest Station

Period :	1969 - 2008
Average rainfall per year :	**1299 mm**
Maximum rainfall per year :	2159 mm
Minimum rainfall per year :	661 mm
Rainy days per year (**average**, max, min) :	**63 d**, 91 d, 34 d
Maximum rainfall (in 1, 2 , 3 and 7 days) :	324 mm, 416 mm, 478 mm, 668 mm
Maximum Rainfall in a month :	785 mm



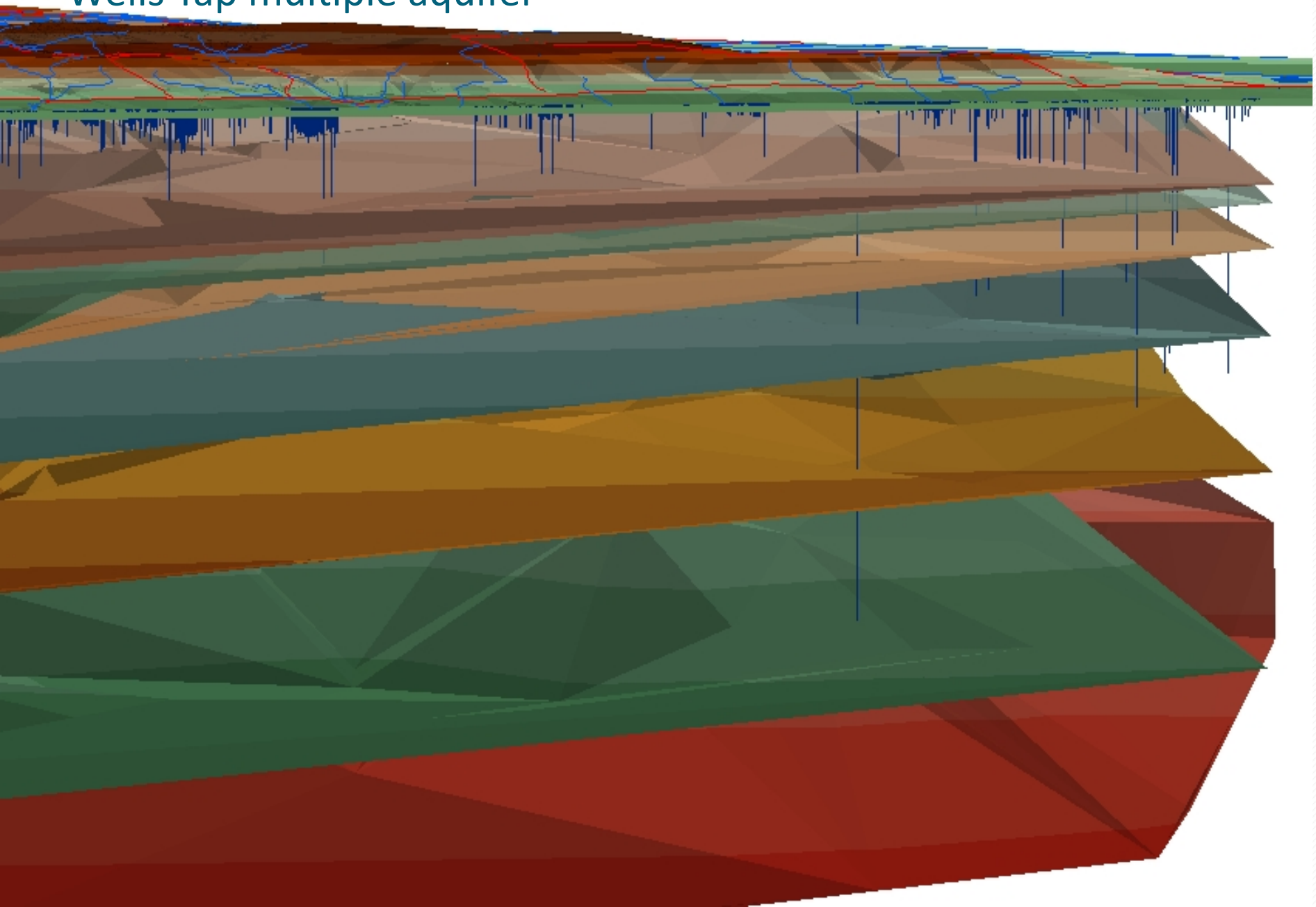
Ground Water

The upper aquifer (Cuddalore) is not water tight



Ground Water

Wells Tap multiple aquifer



Taking Stock

Survey & monitoring

Main issues

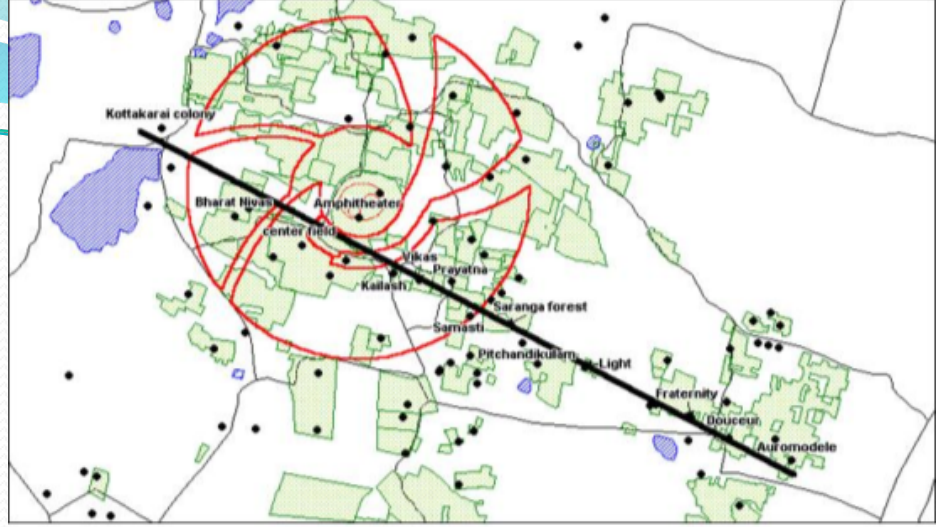
- Poor topographic data
- Ground water level fluctuation and quality cannot be monitored adequately
- Water extraction & consumption ill metered
- Actual Runoff generation unknown
- Data needs constant update for decision making process and crisis management

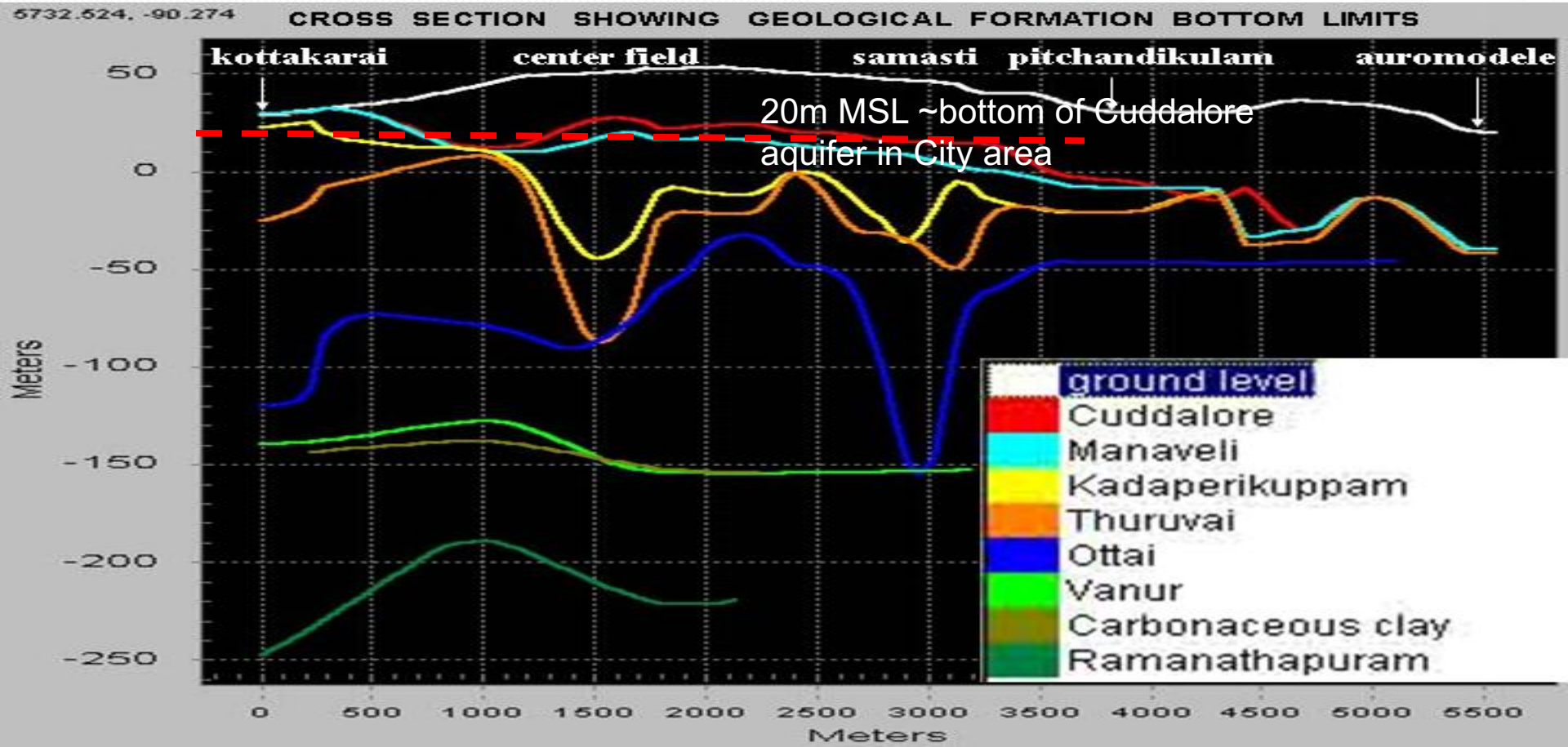
Solutions

- Topographic survey
- Drilling & equipment of aquifer-specific observation wells for monitoring of ground water
- Connected meters on main distribution systems
- Installation of gauges on outlet points of micro-watersheds
- Installation of sensors on observations wells , data integration, map generation, open source

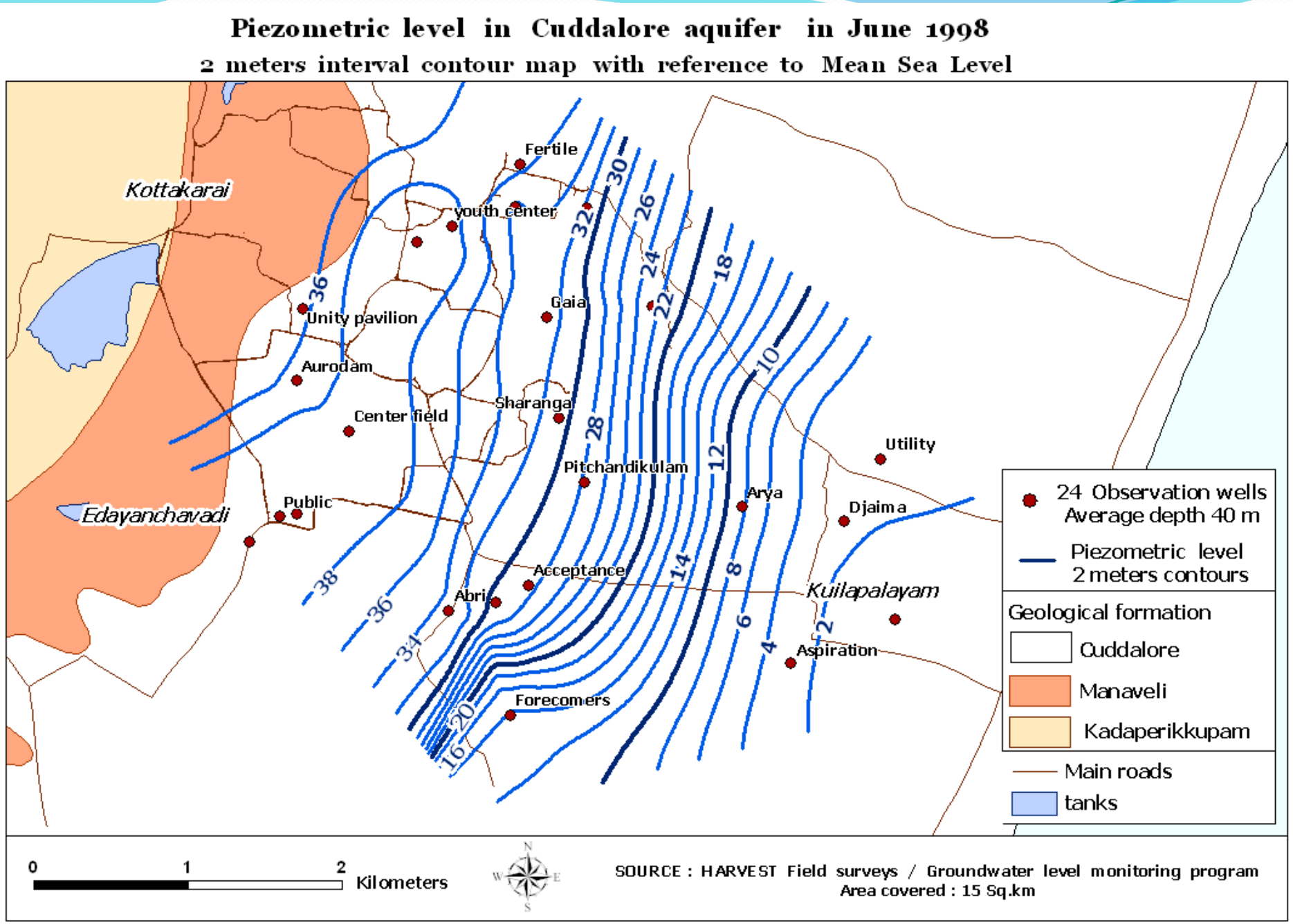
Taking Stock

Ground Water in Auroville



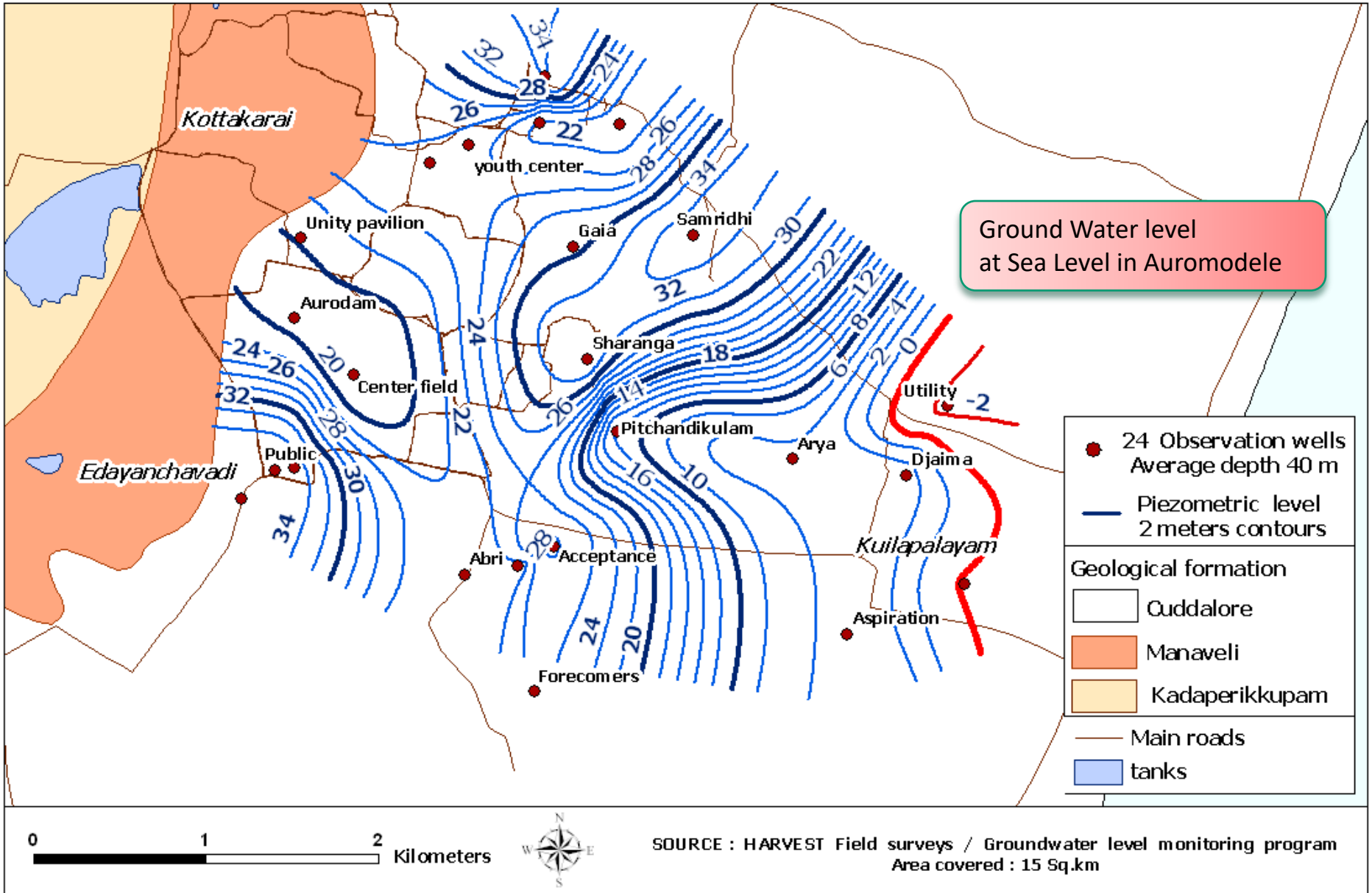


Ground Water decline

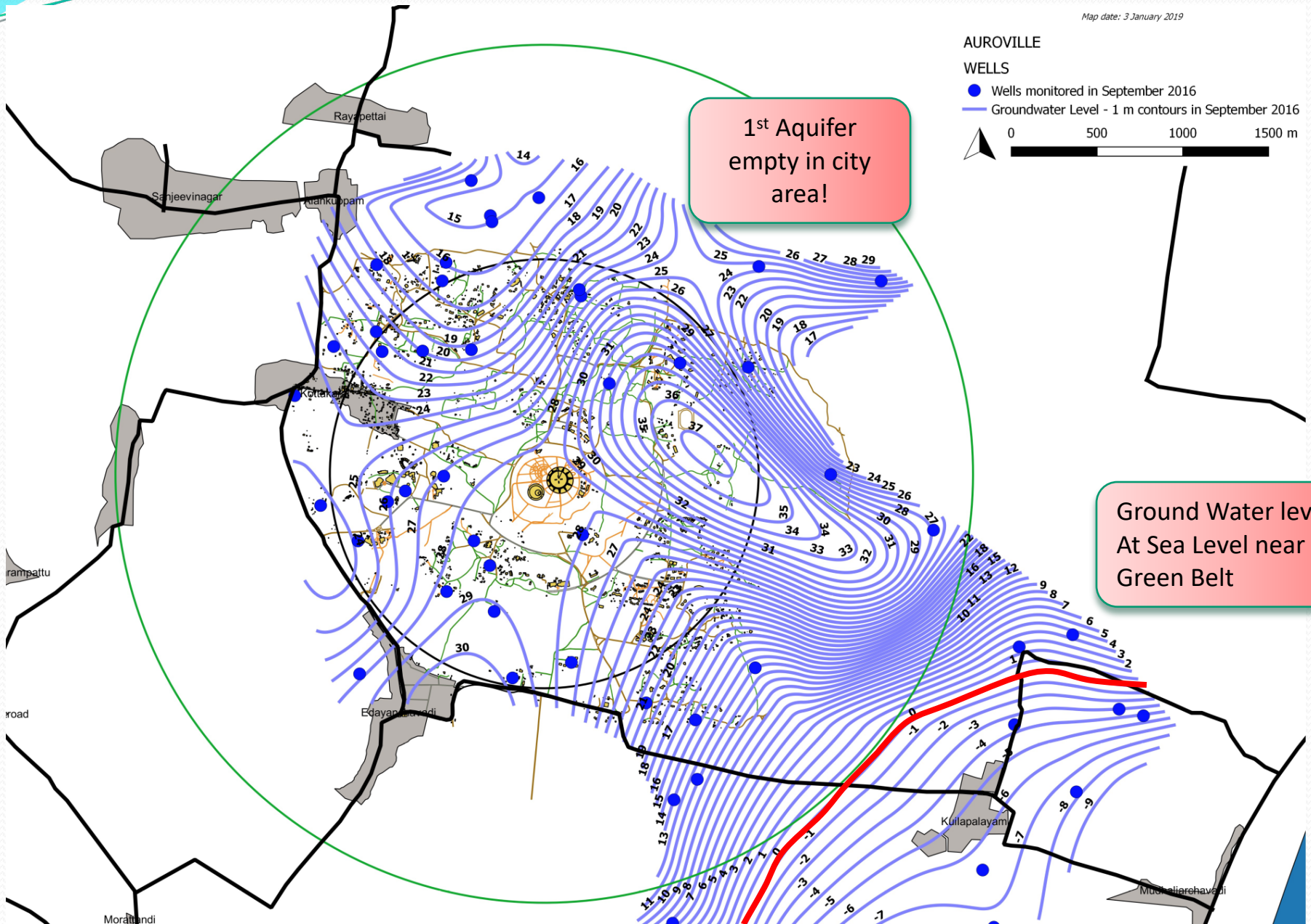


Piezometric level in Cuddalore aquifer in June 2004

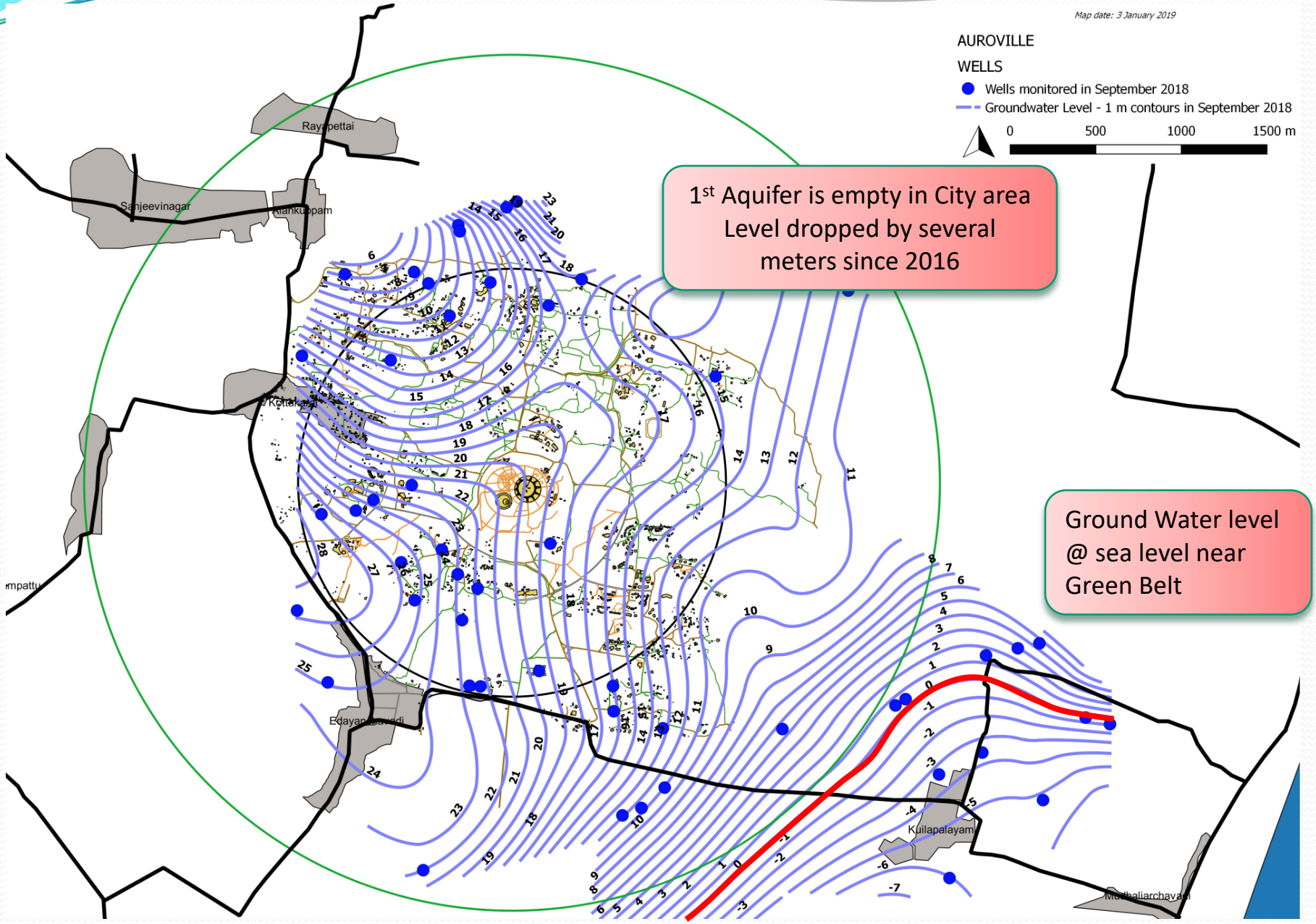
2 meters interval contour map with reference to Mean Sea Level



September 2016



September 2018



Requirement

Survey & monitoring

Solutions

- Drilling & equipment of aquifer-specific observation wells for monitoring of ground water
- Connected meters on main distribution systems
- Installation of gauges on outlet points of micro-watersheds
- Installation of sensors on observations wells , data integration, map generation, open source
- Topographic Survey: on-going

Survey & Monitoring - Projects Short Listed		
2018-19	Installation of 5 contactless connectable flow meters for wells and key part of supply systems	₹4,40,000
	Drilling and equipment of 4 observation wells in 1st aquifer monitoring, including installation of piezometer and transmitter	₹7,54,000
	Drilling and equipment of 4 observation wells in 2nd aquifer monitoring, including installation of piezometer and transmitter	₹9,46,000
2019-20	Installation of 5 contactless connectable flow meters for wells and key part of supply systems	Other Funding
	Drilling and equipment of 4 observation wells in 1st aquifer monitoring, including installation of piezometer and transmitter	Other Funding
	Drilling and equipment of 4 observation wells in 2nd aquifer monitoring, including installation of piezometer and transmitter	Other Funding
	Installation of flow measuring device on Sukhavati check-dam	₹1,92,500
	Total Budget proposed on GOI Grant only	**₹23,32,500**

Taking Stock
Water Sourcing

Main issues

- **Total dependency on ground water**
- Increasing number of wells turning dry during summer
- Yield is decreasing everywhere
- Few wells only offer good yield
- Salinity is increasing along the coast and towards Kaluvelly

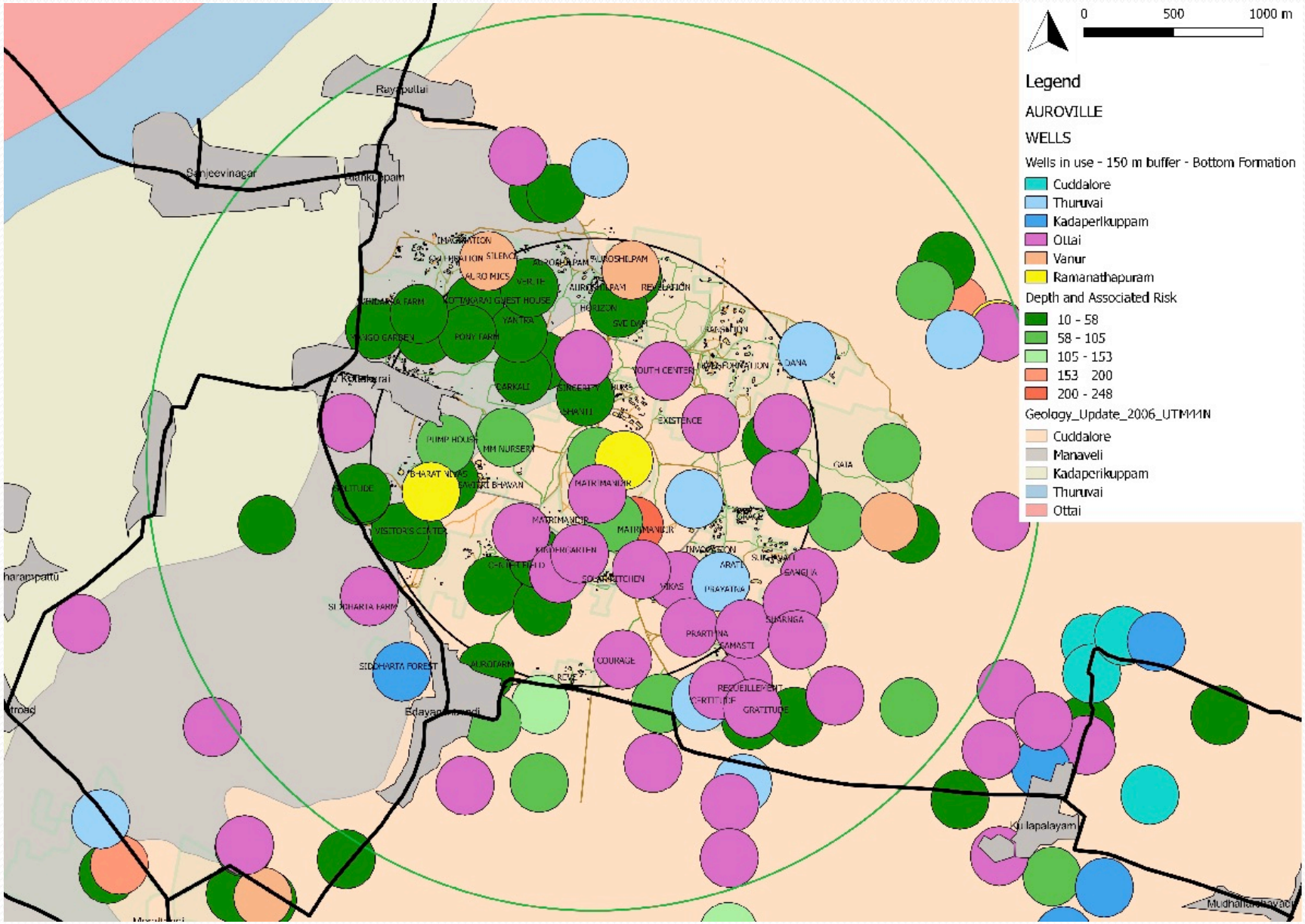
Ground water alone cannot ensure water security to Auroville

Solutions

- Multi-sourcing
  1. **Rainwater harvesting**: offers a very large untapped resource, will increase through development
  2. **Groundwater**: becomes a secondary resource, extraction has to be reinforced locally
  3. **Recycling of wastewater** to reduce fresh water consumption
  4. Promoting **water sa**ving in all fields of activities
  5. **Metering**
  6. **Desalination** of brackish or sea water as a last option

Taking Stock - Water Sourcing

- 270 wells
- 176 wells are in use
- 18 wells feeding supply networks



Requirement

Rain Water Harvesting at city scale

Phase 1: Urban integration in RZ Sector 1&2

Time frame: 2 years

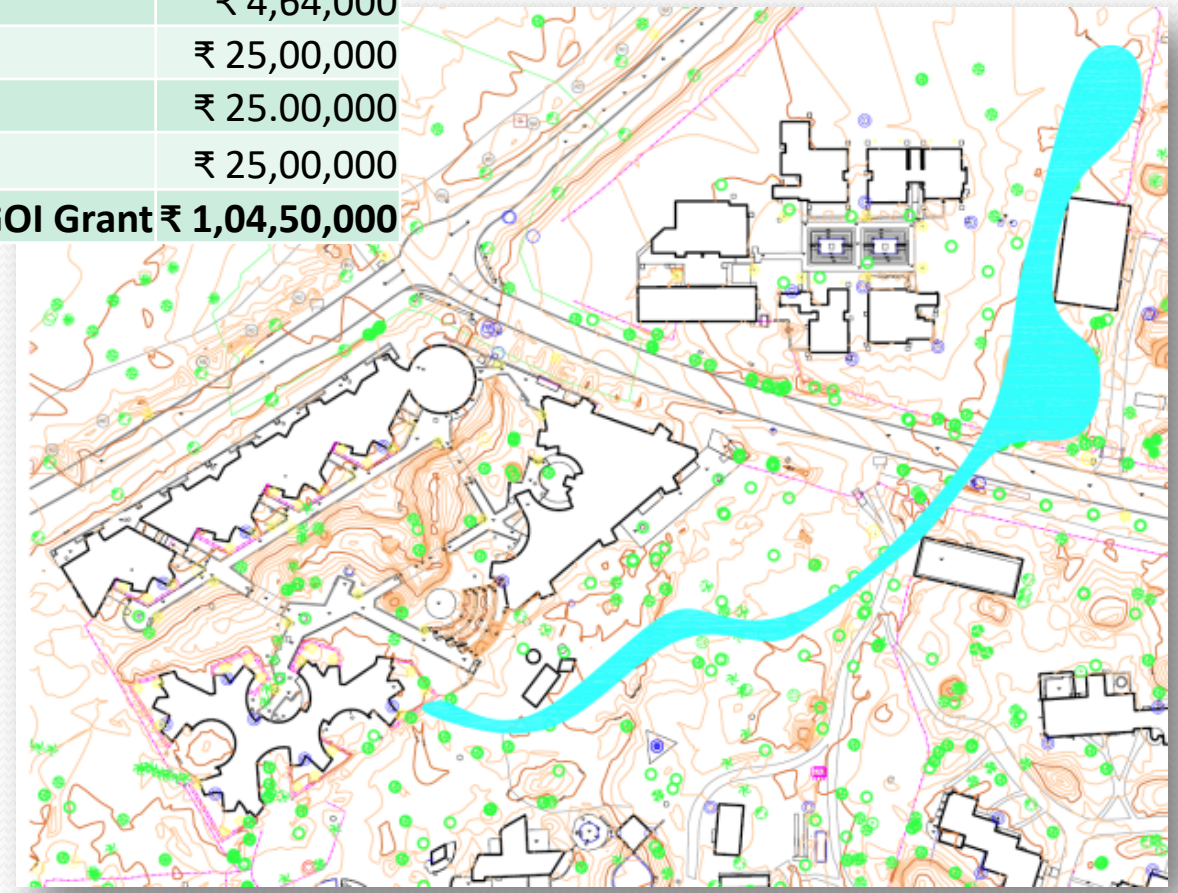
RWH – Projects Short Listed		
2019-20	Pilot project RZ Sector 1&2	₹ 24,86,000
	Safety measures regarding overflow of RZ Sector 2 catchment pond	₹ 4,64,000
2020-21	RWH RZ Sector 1&2 phase 1	₹ 25,00,000
	RWH Sector 1&2 phase 2	₹ 25.00,000
	RWH Sector 1&2 phase 3	₹ 25,00,000
	Total Budget proposed on GOI Grant	**₹ 1,04,50,000**

Development of Rainwater Harvesting system at sub- zonal scale:
Components

- Bio-swale integration in urban fabric
- Storage systems as part of the landscape
- Post treatment
- Connection to supply system

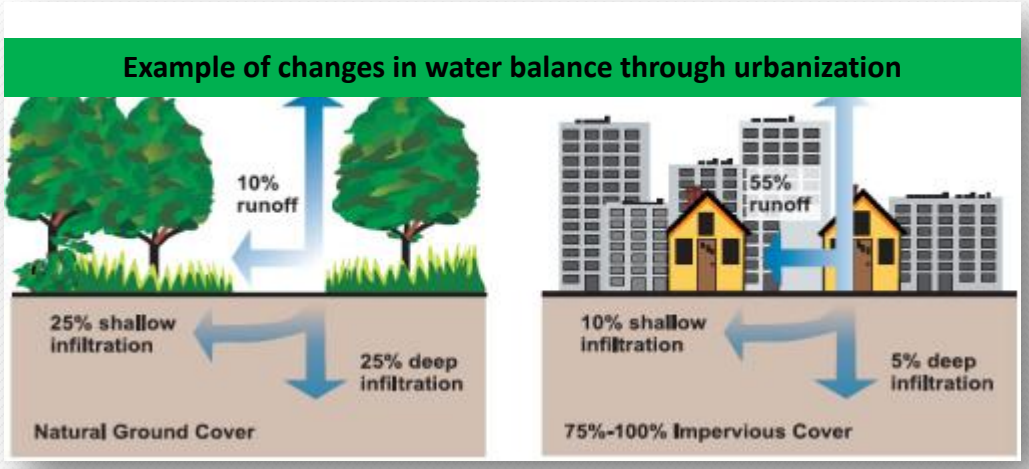
= > 85% reduction

of ground water despondency



Rainwater Harvesting - Strategy

- Urban areas generate massive runoff: 400 to 600l/m2/y for Auroville area (av.)
  - Auroville City area, once developed, will generate enough runoff to feed the entire population on average year.
- Perceived as a nuisance in urban areas, runoff is our most precious resource



- ✓ We must start now!
- ✓ The development of Urban bio swale and storage systems is an absolute priority
- ✓ Matrimandir Lake can and must be part of such system
- ✓ Such system will benefit the larger area by cascading effect

Ref: "Surface Water as a Resource for Auroville City Area, A study exploring a multi-sourcing approach for Auroville with the integration of Matrimandir Lake" -2012, presented to Governing Board, approved by Dr. Doshi, Chairman of TDC

RWH as a resource

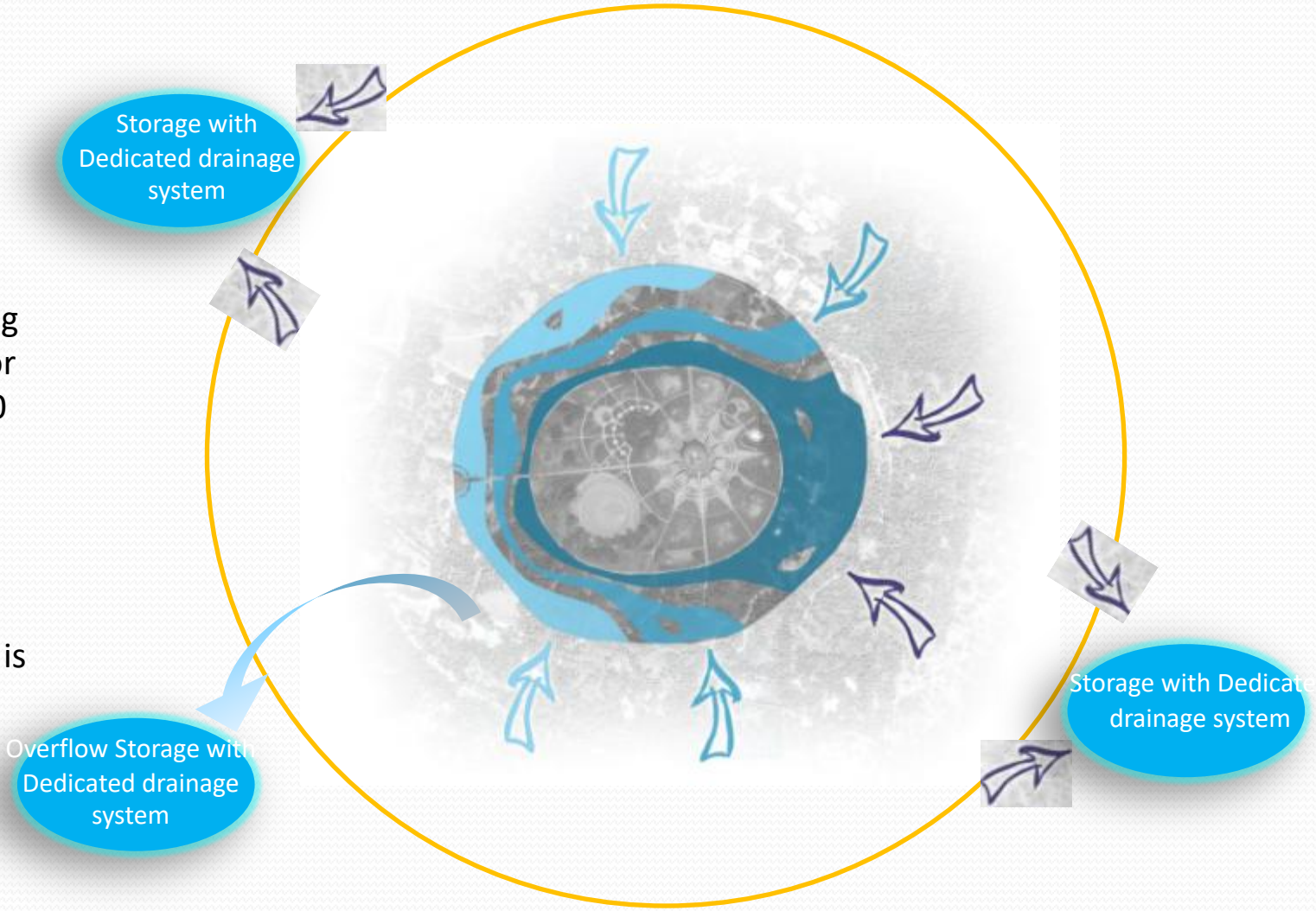
Future development: Integration of Matrimandir Lake

- Each terraced section of the lake can be fed by a dedicated drainage system, in accordance to the topography, overflowing to the terrace below.
- Matrimandir lake will generate at time very large overflow which can be collected in a secondary tank.

RWH as a resource

Extension at city scale … And further

- Other parts of the city can be drained to separate water bodies, ensuring water supply for the final 50,000 people.
- A modular design of the drainage and storage system is recommended.



Requirement

Water Sourcing - others

- In some areas water accessibility is unsafe
- Other sources need time to be made available
- Extra wells needed

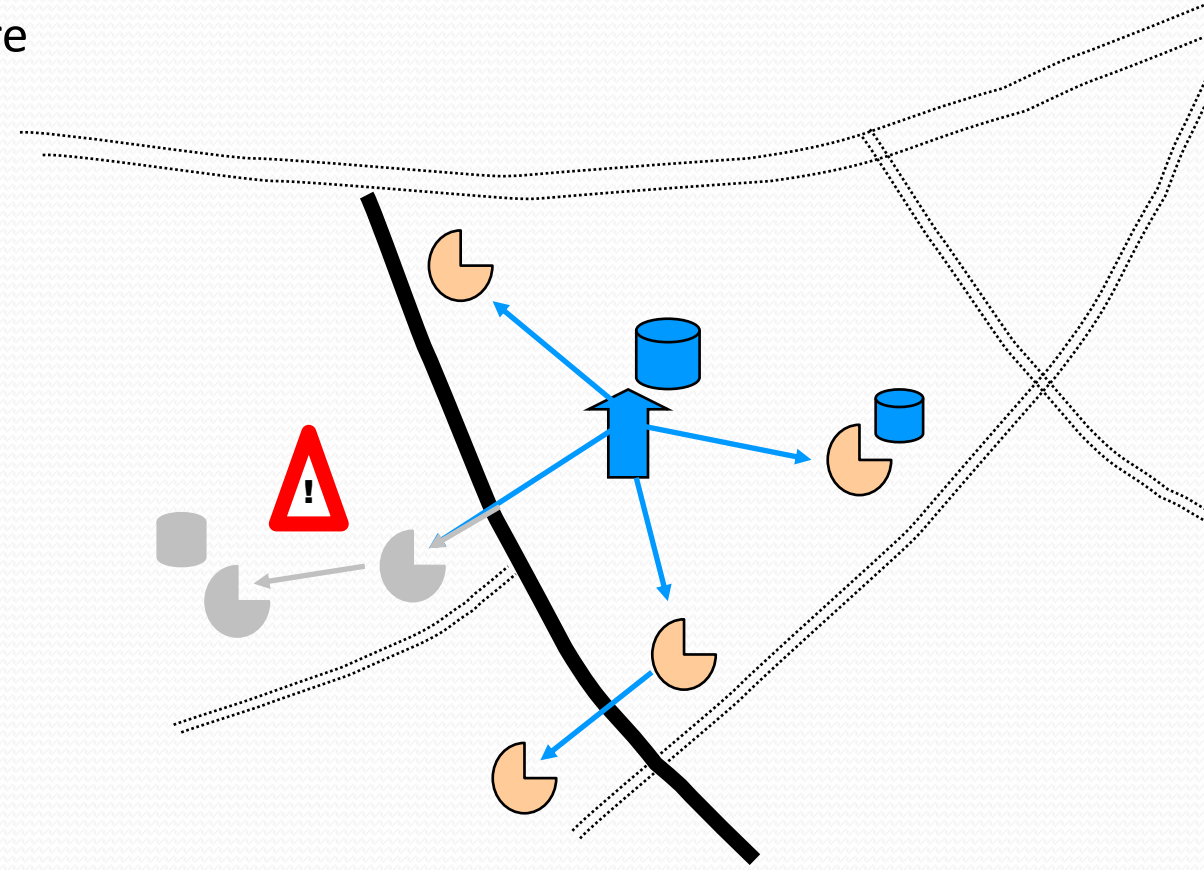
Water Sourcing Others – Projects Short Listed		
2019-2020	Drilling and equipment of 1 well in RZ	3,75,100
	Drilling and equipment of 1 well in CZ	3,75,100
	Drillling and equipment of 1 Horizontal well in IntZ	5,45,600
	Drilling of 1 well in Auromodel area and connection to existing system	Other Funding
	Total Budget proposed on GOI Grant only	**₹ 12,95,800**

Taking Stock

Water Supply - Present situation

- Most water supplied by cluster
- 10 larger supply network fed through single or several wells
- Networks in tree structure

- Main Drawback
  - No or poor back-up
  - Poorly documented
  - Can lead to supply failure!



Taking Stock - Water Supply & Accessibility

Funded by GOI Grant

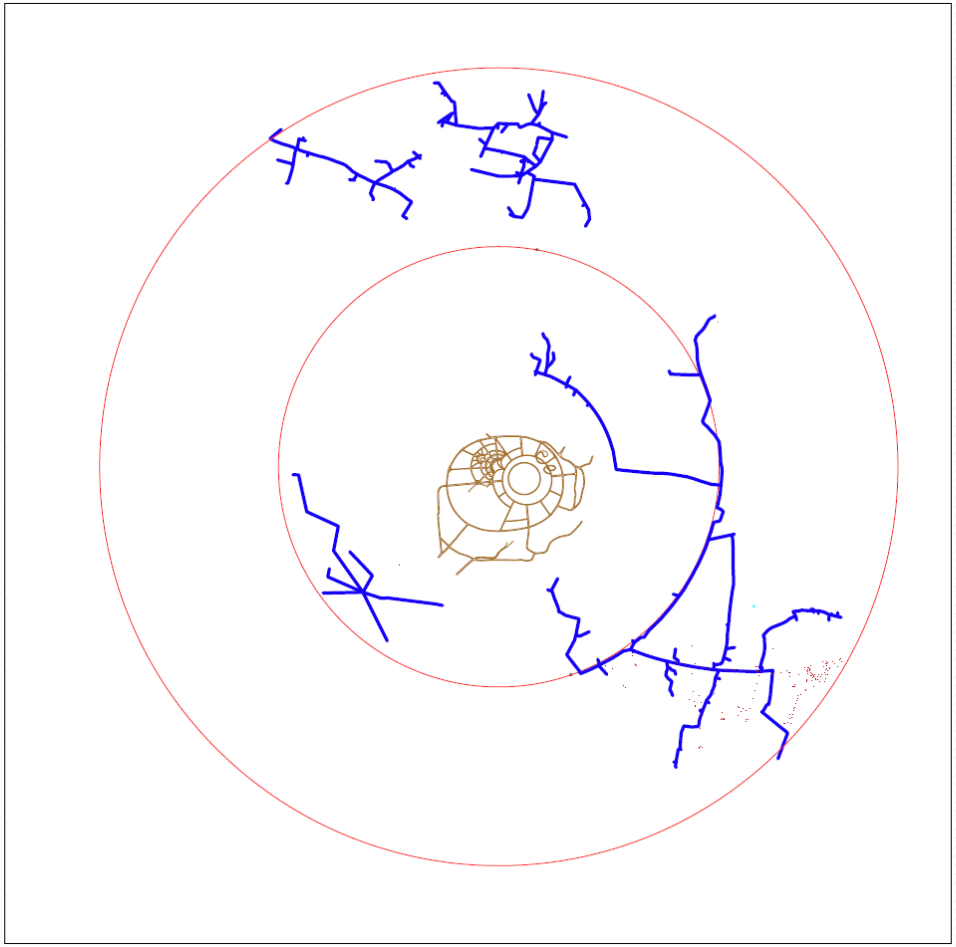
GOI GRANT for WATER SUPPLY through TDC			
2011 - 12	Water Tower system	Main distribution pipe line - Phase 1	₹ 32,19,958
	Industrial Zone	Construction of underground sump @ Auroshilpam	₹ 13,00,000
	Industrial Zone	Drilling, Development, Equipment and connection of a bore well at IDZ	₹ 8,00,000
	Water Tower system	Main distribution pipe line 1st part	₹ 58,89,958
2014-15	Water Tower system	Pipe line from Gaia to Habitat / Admin area	₹ 25,70,000
	Industrial Zone	Pipeline from Silence to Yantra (IDZ)	₹ 22,77,000
2015 - 16	Industrial Zone	Additional work Pipeline from Silence to Yantra (IDZ)	₹ 2,49,676
	Water Tower system	Pipeline to Prayathana - Prarthana	₹ 16,46,988
	Water Tower system	Pipeline to Maitreye	₹ 10,43,893
		TOTAL till date	**₹ 1,89,97,473**

Taking Stock: Water Supply

Present situation- Supply Networks

- Most places supplied by a single well => no safety
- Networks in tree structure => not optimal
- 10 supply networks fed through single or several wells

Main Network	Length of piping mts	Source of water	Connected Communities
RZ-Water Tower	~5065	5 BWs, all in RZ	42
Kinder Garden Solar Kitchen	400	1 BW + 1 loose backup	10
Centre Field MT well	1340	1 BW	9
Courage	~1000	1 BW	7 + RZ Water Tower
Auroshilpam	2175	2 BW	11
Silence well	1200	1 BW	5
Kalabhumi	?	1 BW	5
Transition	?	1 BW	4
Aurelec – Fraternity-New Creation	~1200	3 BW	4
Auromodele	~2500	1 BW	9



Water supply networks

Status

Main Network	Source of water	Connected Communities	Status	Recommendation for immediate actions	Planning
Water Tower	5 BW	42	• All sources (BW) in a small area of RZ • Network overstretched • 2 wells not in good condition • No sufficient safety	✓ Consolidate accessibility by connecting other existing wells ✓ Limit this network to RZ sector 1 and 2 ✓ O&M on wells necessary	2019-20: 1st phase proposed
Kinder Garden Solar Kitchen	1 BW + 1 loose backup	10	• No backup • Fragile area	✓ 4 Local wells to be interconnected ✓ Development of common storage tank ✓ Interconnection of local networks	4th quarter 2018-19 & 2019-20: 1st phase proposed
Centre Field MT well	1 BW	9			
Courage – Service Area	1 BW	7 + RZ Water Tower	•No backup • Fragile area	✓ Development of a new well in this sector ✓ Development of common storage tank	2019-20: 1st phase proposed
Auroshilpam area – IndZ	2 BW	11	• Wells so far healthy • Large storage tank implemented in CSR • Network in Auroshilpam old and outdated	✓ Connect wells and supply systems to storage tank ✓Upgrade network in Auroshilpam ✓Develop network at zonal level	2019-20: 1st phase proposed
Silence area - IndZ	1 BW	5			
Kalabhumi	1 BW	5	• No backup • Fragile area • Piping is outdated	✓ 3 wells to be interconnected ✓Development of common storage tank ✓ Development of supply network at sub-zonal scale	4th quarter 2018-19: initiated 2019-20: 1st phase proposed
Transition	1 BW	4			
Aurelec-Fraterity -NC	3 BW	4	• Piping is outdated	-	
Auromodel	1 BW	9	• No backup	✓ Development of new well	2019-20: proposed

Water Supply: Strategy

Securing Water Accessibility through sub-zonal supply network

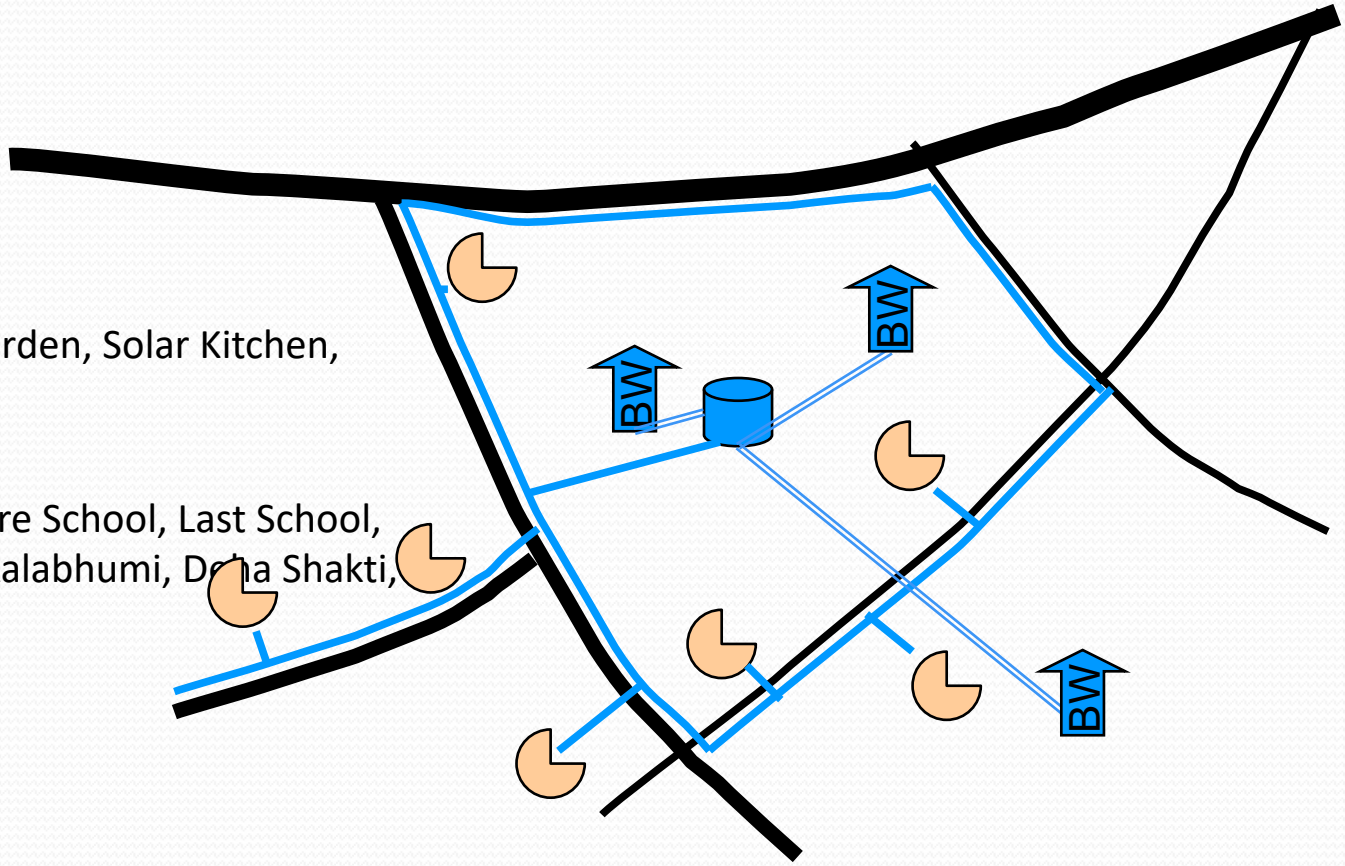
Time frame: 2 years

1- Interconnection of bore wells at sub-zonal level

2- Common sumps at sub-zonal level

3- Development of Supply networks at sub-zonal scale

- Loop networks type
- Connected Metering



Targeted Areas:

1. Residential Zone
   - Centre Field, Kinder Garden, Solar Kitchen, Aurodam
2. Cultural Zone
   - Transition School, Future School, Last School, SAAIIER staff quarter, Kalabhumi, Deha Shakti, Youth Centre
3. Service Area
4. Industrial Zone
5. Auromodele Area

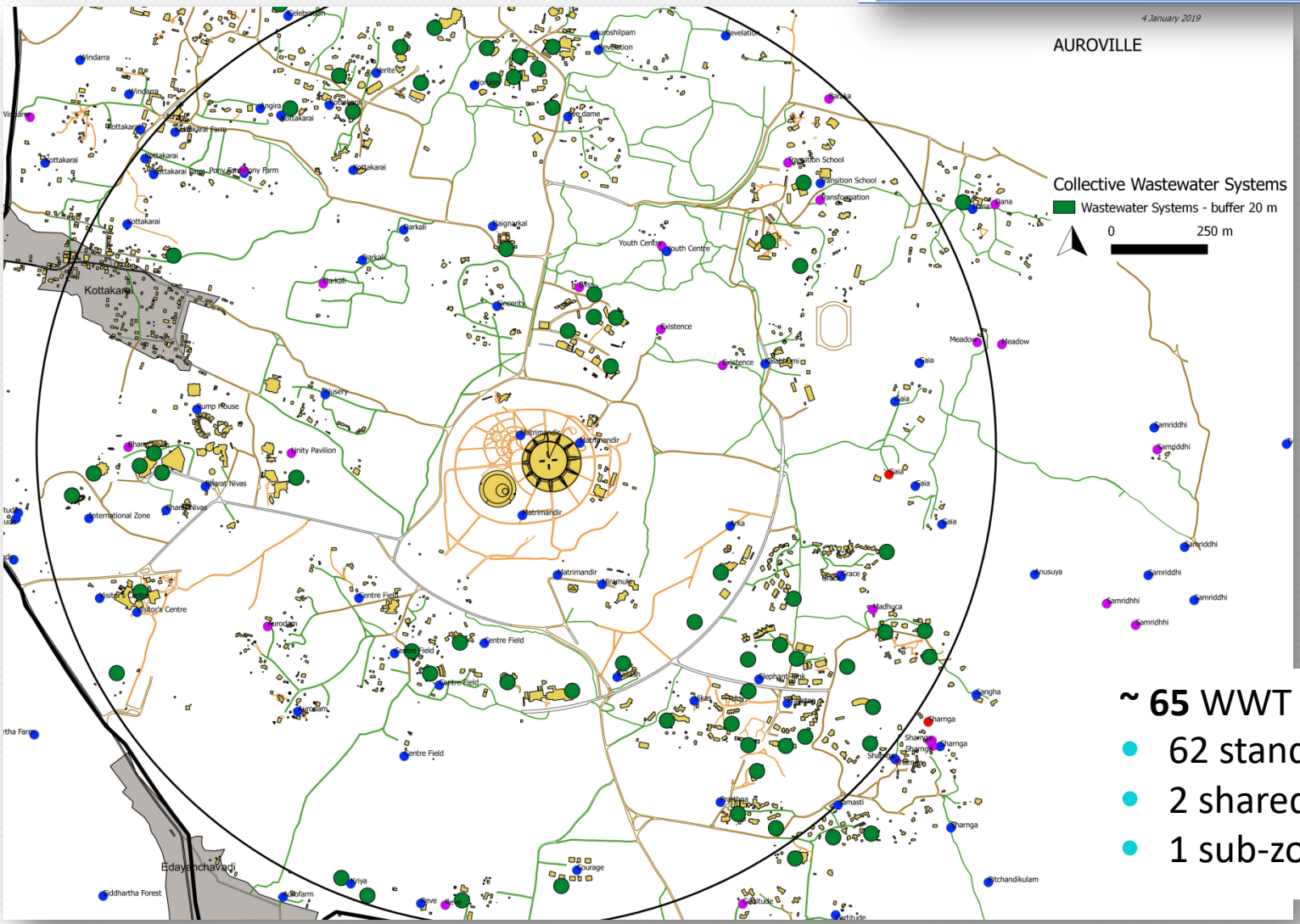
Requirement

Water Supply & Accessibility

Water Supply Other– Projects Short Listed			
2019-20	Water Tower system	Filtration unit on 1 well in RZ	₹ 1,81,500
2020-21	Water Tower system	Connection of new RZ well to RZ supply system	₹ 3,53,100
	Water Tower system	Replacement of pipe lines from PVC to HDPE in RZ	₹ 5,91,800
	RZ Centre Field	Interconnection of wells in RZ - Centre Field area	₹ 4,77,400
	Cultural Zone	Interconnection of wells in CZ - Transition, Kalabhumi, Youth Centre	₹ 5,34,600
		Total Budget proposed on GOI Grant only	**₹ 21,38,400**

Taking Stock

Wastewater management



~ 65 WWT in Auroville

- 62 stand alone
- 2 shared facilities
- 1 sub-zonal system

Wastewater management - Strategy

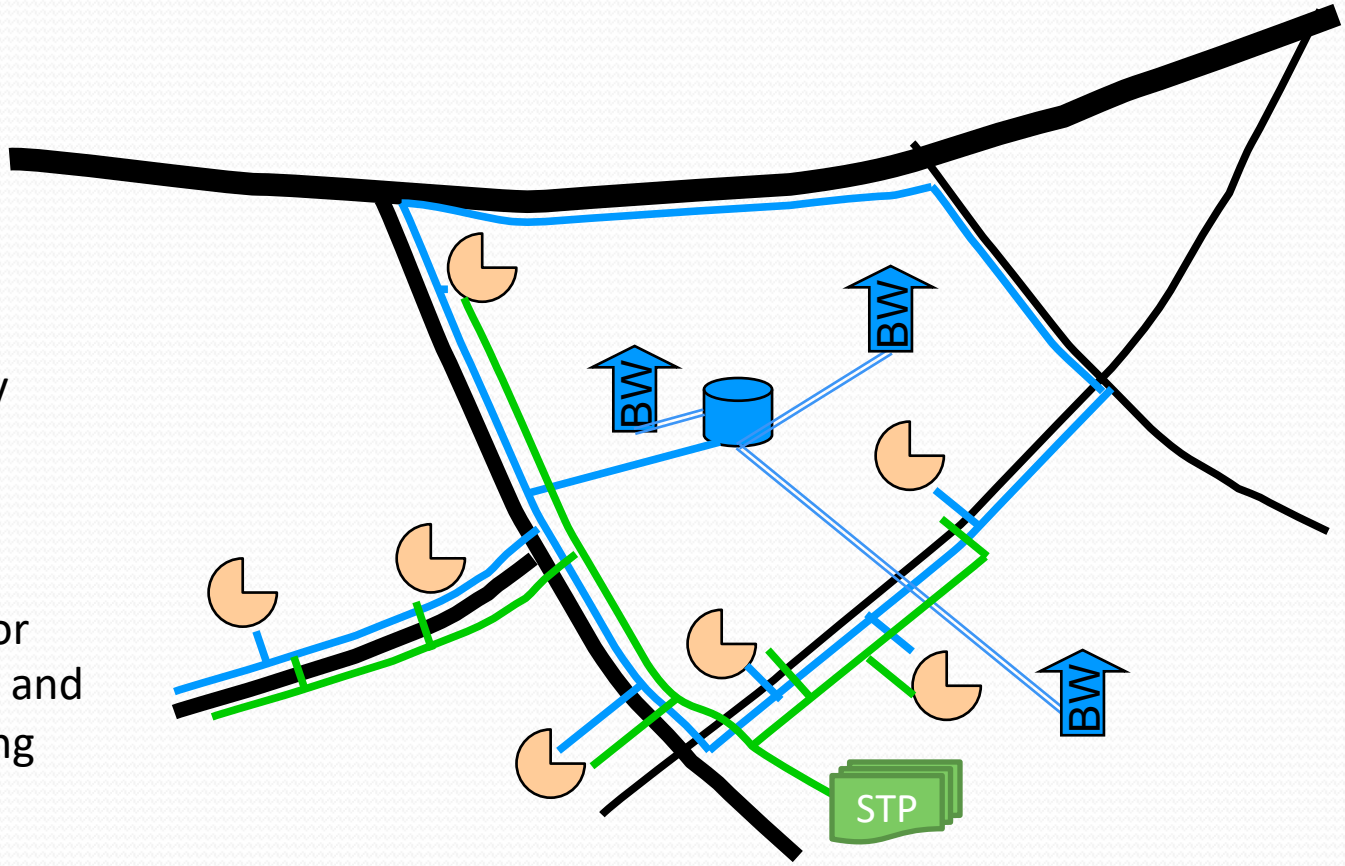
Reducing fresh water consumption through recycling of wastewater

Strategy

1. Development of collection and treatment facilities at sub-zonal scale
2. Access to recycled water for irrigation purpose
3. Provision for safe in-house recycling at community level

Actual situation

- Most of treatment systems are for single house or community
- Recycling is so far very limited
- The common infrastructure for Residential Zone Sector 1&2 can be extended and allows for safe recycling for gardening and in Matrimandir



Taking Stock

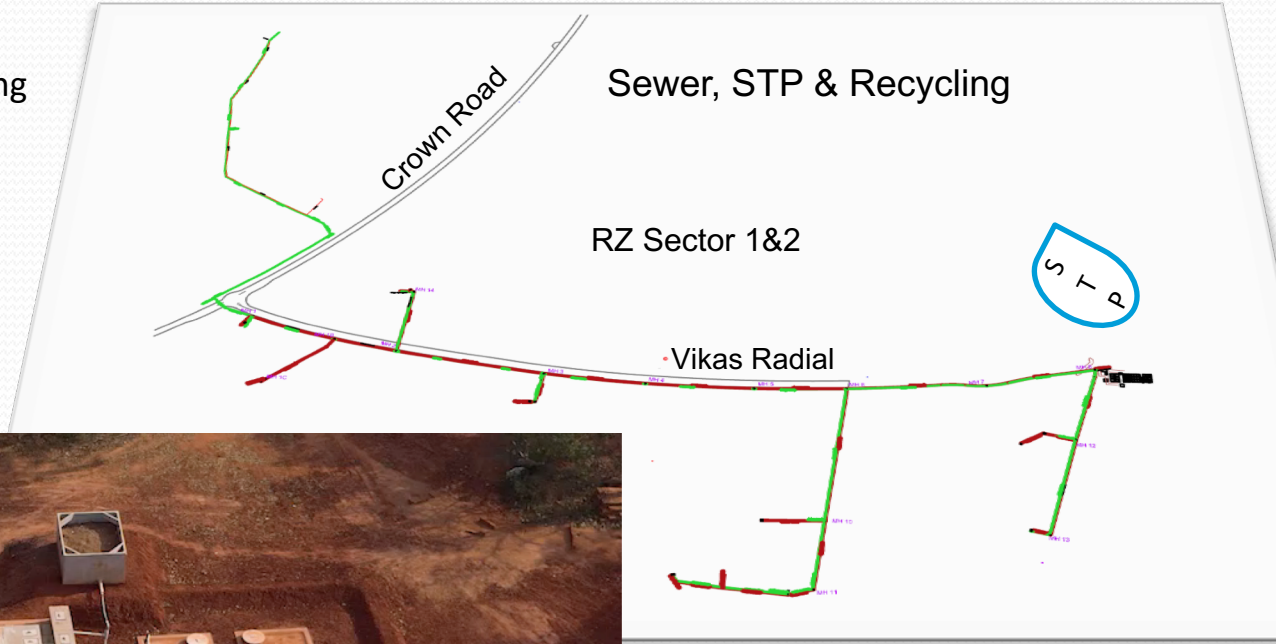
Wastewater management

Common infrastructure development in RZ

GOI GRANT for WASTEWATER MANAGEMENT through TDC		
2016	Sewer & manholes RZ Sector 1&2	₹ 73,80,947
2016	STP RZ Sector 1&2	₹ 52,63,202
2018-2019	Additional equipment STP RZ	₹ 4,91,669
2018-2019	Return line RZ Sector 1&2	₹ 47,58,828
2018-2019	Mahalakshmi Home - Treatment plant	₹ 6,10,000
	TOTAL till date	**₹ 1,85,04,646**

- **Sewer**: extendable to the full sector 1&2
- **Prefabricated Modular STP**. Actual capacity 60KLD
- **Return line** for irrigation recycling
- **Can be upgraded** to in-house recycling

Connected community till date: **8**



Requirement

Wastewater management

WWM– Projects Short Listed		
2018-19	Extension of STP in RZ 1st phase	22,03,300
	New connections : 4	10,21,460
	Additional Work on sewer	1,54,000
2019-20	Extension of STP in RZ 2nd phase	40,70,000
	New connections: 4	19,50,300
	Additional Work on sewer	12,92,500
	Additional Work on Return line	1,32,000
	Total Total Budget towards GOI only	**1,08,23,560**

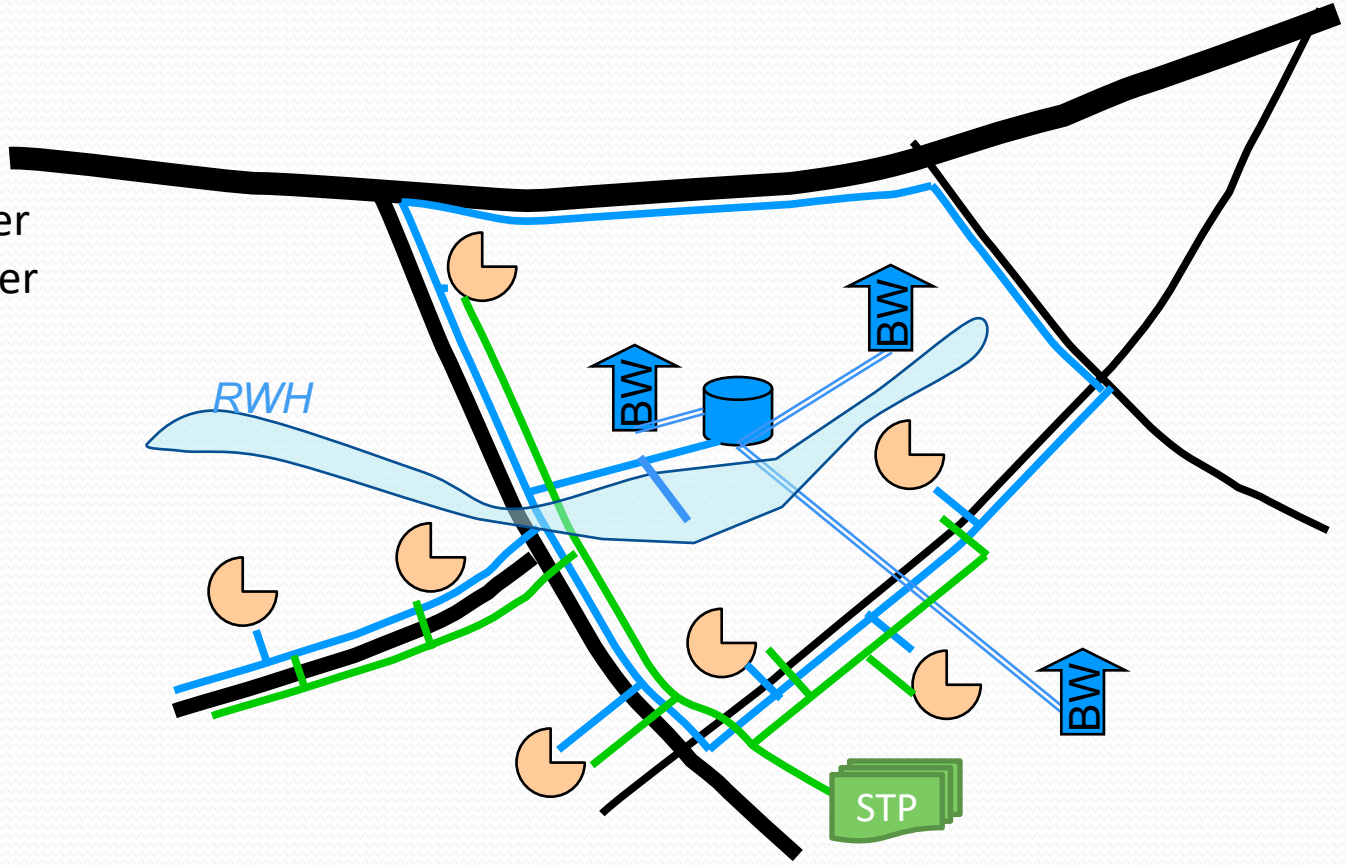
Multi-sourcing

Strategy

- Development of urban swales, storm water storage, filtration , connection to supply system at sub-zonal scale
- Access to recycled water for irrigation and in-house recycling
- Ground water as a backup

Actual situation

- One single fresh water resource: ground water
- Wastewater is often treated , not recycled
- Drainage system not integrated in present urban layout



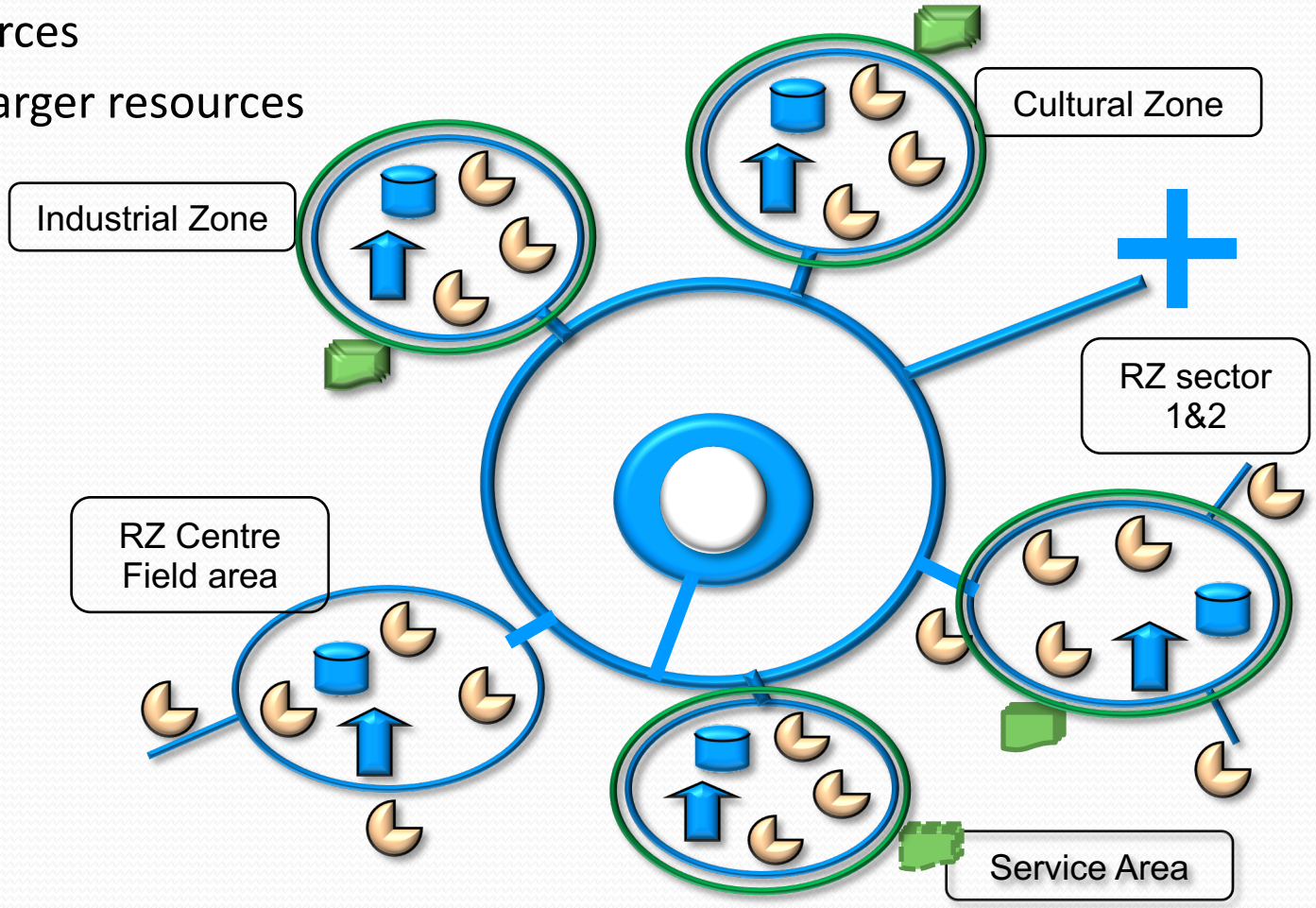
Multi-sourcing

Strategy

Extension to Zonal / City Scale

Time frame: 1st phase - 3 years

- Interconnectivity through a main feeder
- Sharing of resources
- Safer access to larger resources

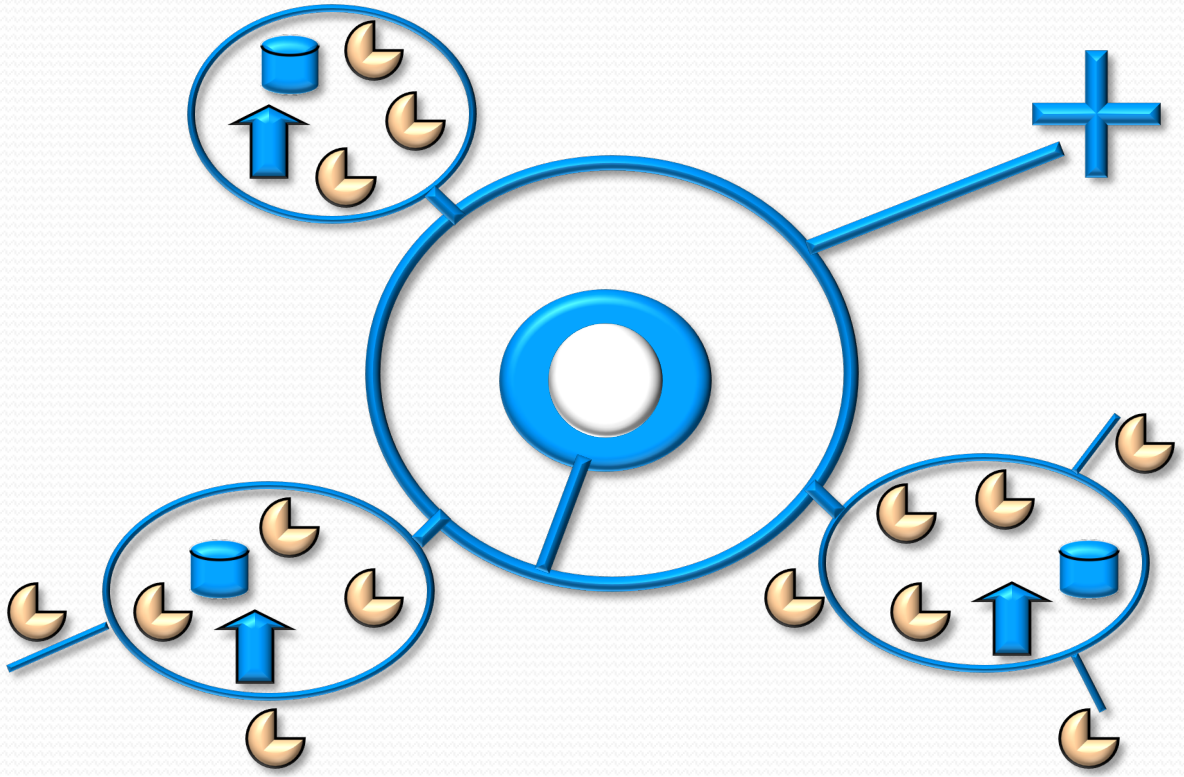


Multi-sourcing

Building up the resilience

The way forward

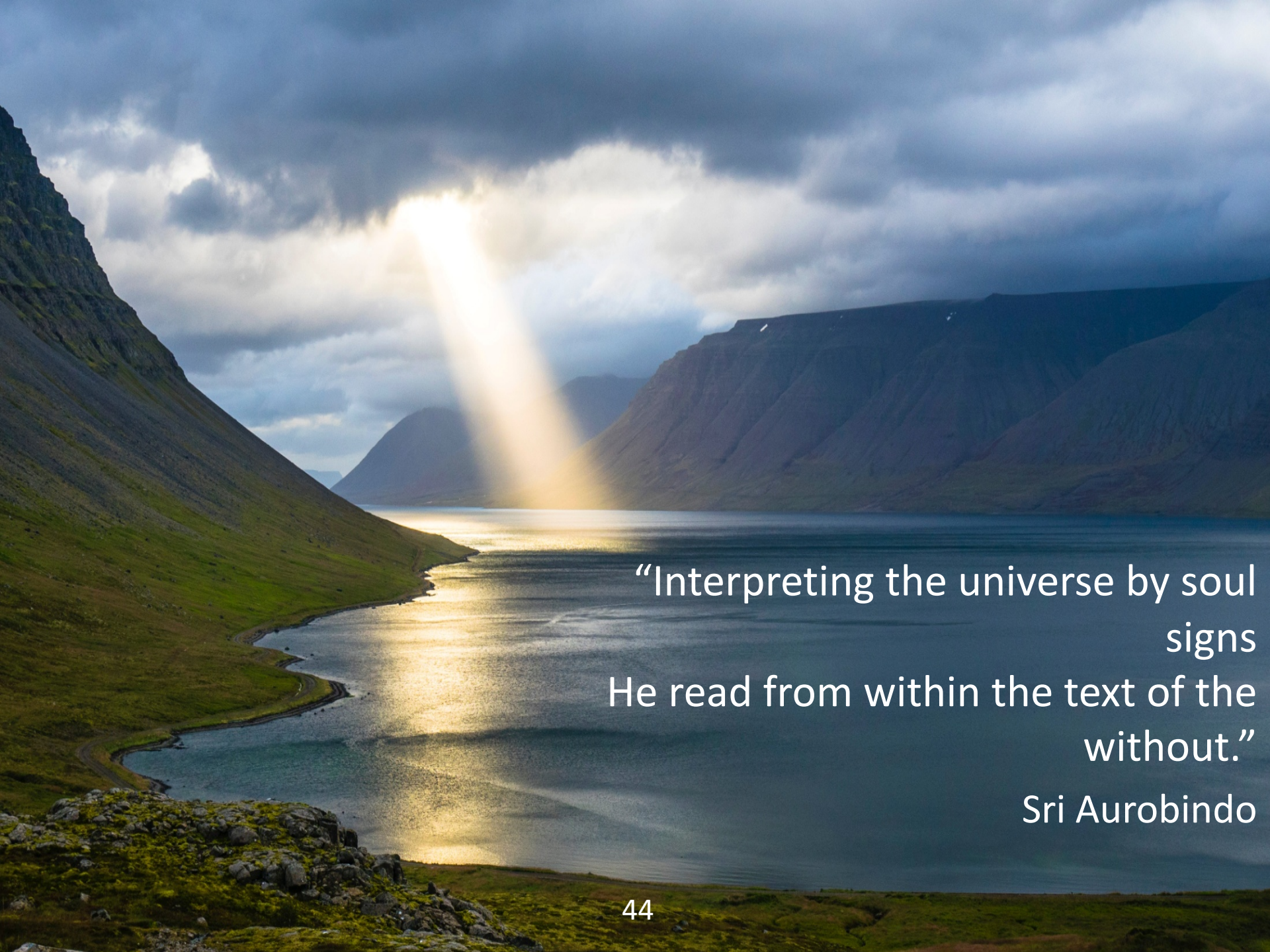
1. Surface water, Ground water, Matrimandir lake, desalination…
2. Securing water accessibility
3. Benefitting the larger area



Requirement

Water Infrastructure Development

Financial year 2018-19, 2019-20	
Survey & Monitoring	23,32,500
Sourcing - RWH	1,04,50,000
Sourcing - Other sources	12,95,800
Supply	21,38,400
WWM	1,08,23,560
TOTAL	**2,70,40,260**


“Interpreting the universe by soul signs
He read from within the text of the without.”
Sri Aurobindo