Begins in:

ICE WaRM
International Centre of Excellence in Water Resources Management

Webinar: Hard rock groundwater recharge using check dams in Rajasthan, India and its relevance to South Australia

Presented by Yogita Dashora and Dr Peter Dillon

Australian Government

Australian Water School

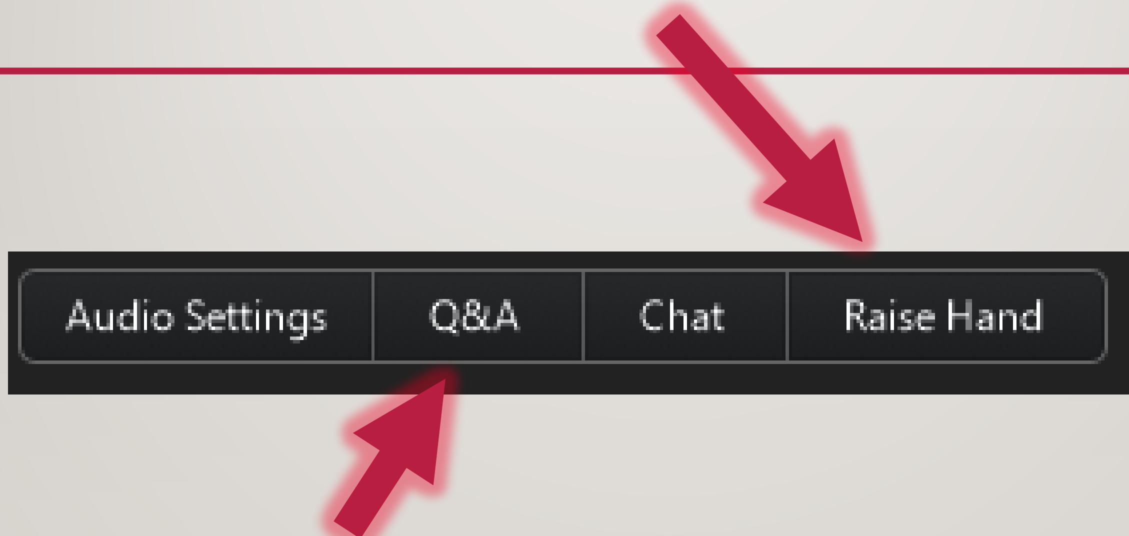
CHAIR

Trevor Pillar,

National Partnerships Manager,

ICE WaRM

TEST



Please click on Q&A and start writing questions as they come to mind.

UP COMING Training in the Australian Water School:

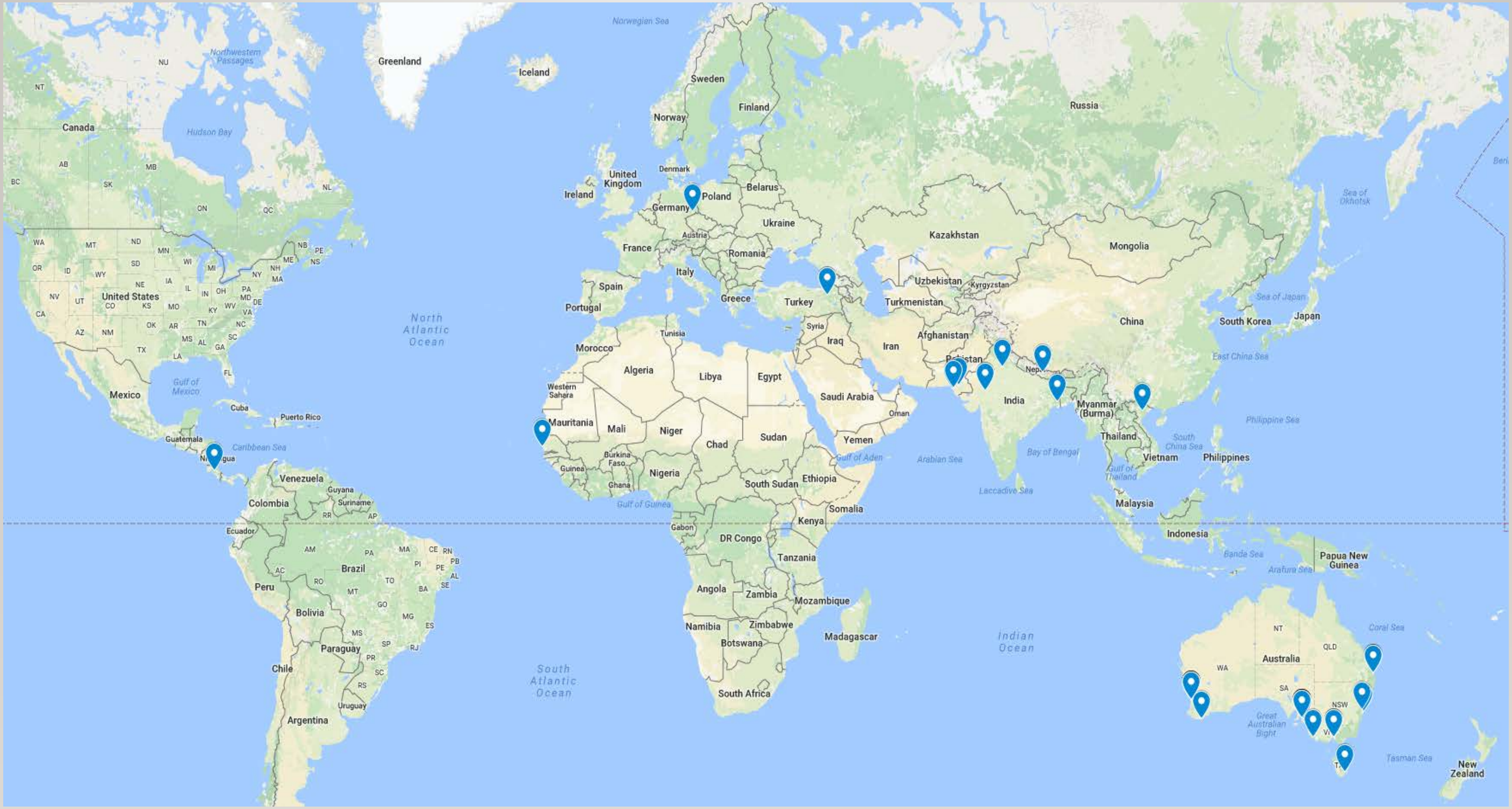
- **Webinars:**
  - **Thurs 29th June 2017: Next Generation Irrigation Management**: *Tim Hyde, Ivor Gaylard*
  - **Thurs 6th July 2017: MAR for Water Utilities:** *Greg Ingleton*
  - **Thurs 27th July 2017: Community Wastewater Reuse with HRAP #2**: *Howard Fallowfield*
  - **Thurs 31st Aug 2017: Water Research Australia:** *Peter Brass*

- **Face-to-Face:**
  - Managing Your Water Asset: Workshop Mon 3rd July 2017, Loxton Research Centre
  - HEC-RAS Water Modelling: 11th -15th Sept 2017, BRISBANE
  - MAR Essentials Workshop: 26th – 27th Oct 2017, PERTH

AGENDA today:

- **Format:**
  - 25 mins: **Presentation**
  - 25 mins: **Q&A** open to all
- **Recording**- will be sent to all
- **Feedback**
  - 1 minute after Webinar
  - All comments welcome- helps shape future webinars

Today’s Attendees:



Today’s Presenters:

Yogita Dashora
Maharana Pratap University of Agriculture and Technology, Udaipur

Yogita has four years experience in research, field work and extensions related to Groundwater recharge estimation in Irrigation Water Management. Yogita is now completing the writing of her PhD thesis entitled: “Evaluating the Effectiveness of Managed Aquifer Recharge Structures in the Dharta Watershed, Rajasthan, India”.

Yogita Dashora
PhD Candidate MP University India

Dr Peter Dillon
Groundwater Scientist and Engineer

Dr Dillon has 25 years’ research experience in surface water-groundwater interaction, groundwater quality protection from diffuse and point sources and agricultural water reuse. As a CSIRO Research Scientist, Peter has led research on managed aquifer recharge with stormwater and reclaimed water for over a decade. Peter was Director of the Centre for Groundwater Studies which merged into the National Centre for Groundwater Research and Training.

Dr Peter Dillon
Groundwater Scientist & Engineer

*Please click on **Q&A and** start writing questions as the Presenter begins. Then they’ll be ready for the Q&A.*

HARD ROCK GROUNDWATER RECHARGE USING CHECK DAMS IN RAJASTHAN, INDIA AND ITS RELEVANCE TO SOUTH AUSTRALIA

PRESENTED BY: YOGITA DASHORA AND PETER DILLON

AND MARVI TEAM,

THURSDAY 15TH JUNE 2017

dashora.yogita@gmail.com

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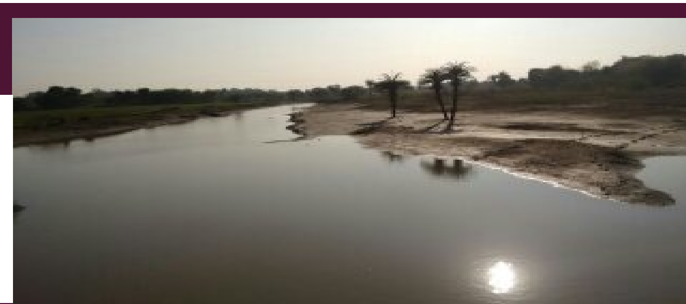
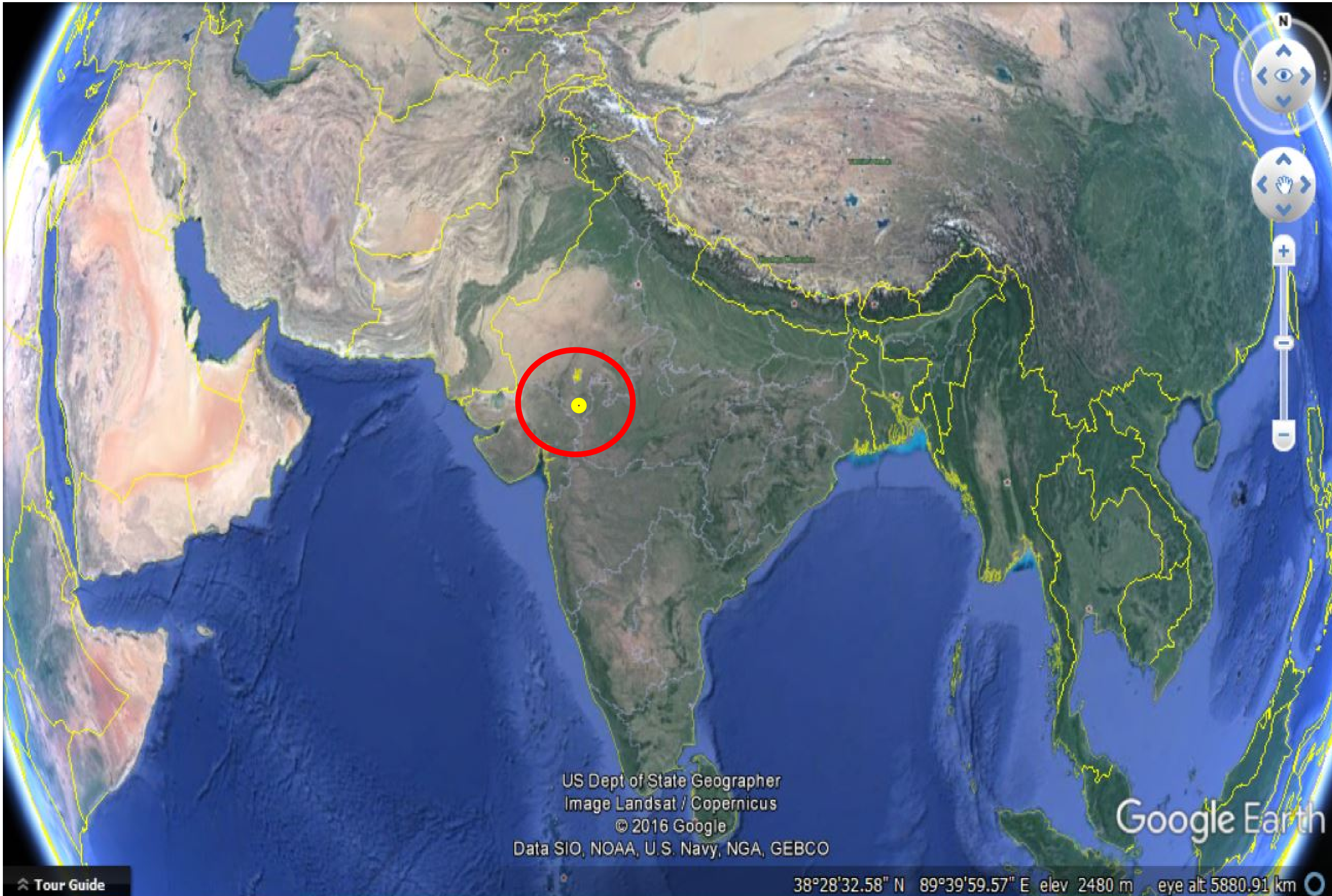


INTRODUCTION

- Rajasthan is the largest state of the country and has scanty rainfall.
- 91% of the State's drinking needs and 60% of its irrigation requirements are fulfilled by groundwater.
- To increase the recharge opportunity, aquifers are artificially recharged in stressed areas.
- MAR methods include aquifer storage and recovery; transfer and recovery; infiltration ponds; infiltration galleries; soil aquifer treatment; percolation tanks and check dams (Dillon et al. 2009).


US Dept of State Geographer
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Tour Guide
38°28'32.58" N 89°39'59.57" E elev 2480 m eye alt 5880.91 km
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LOCATION MAP

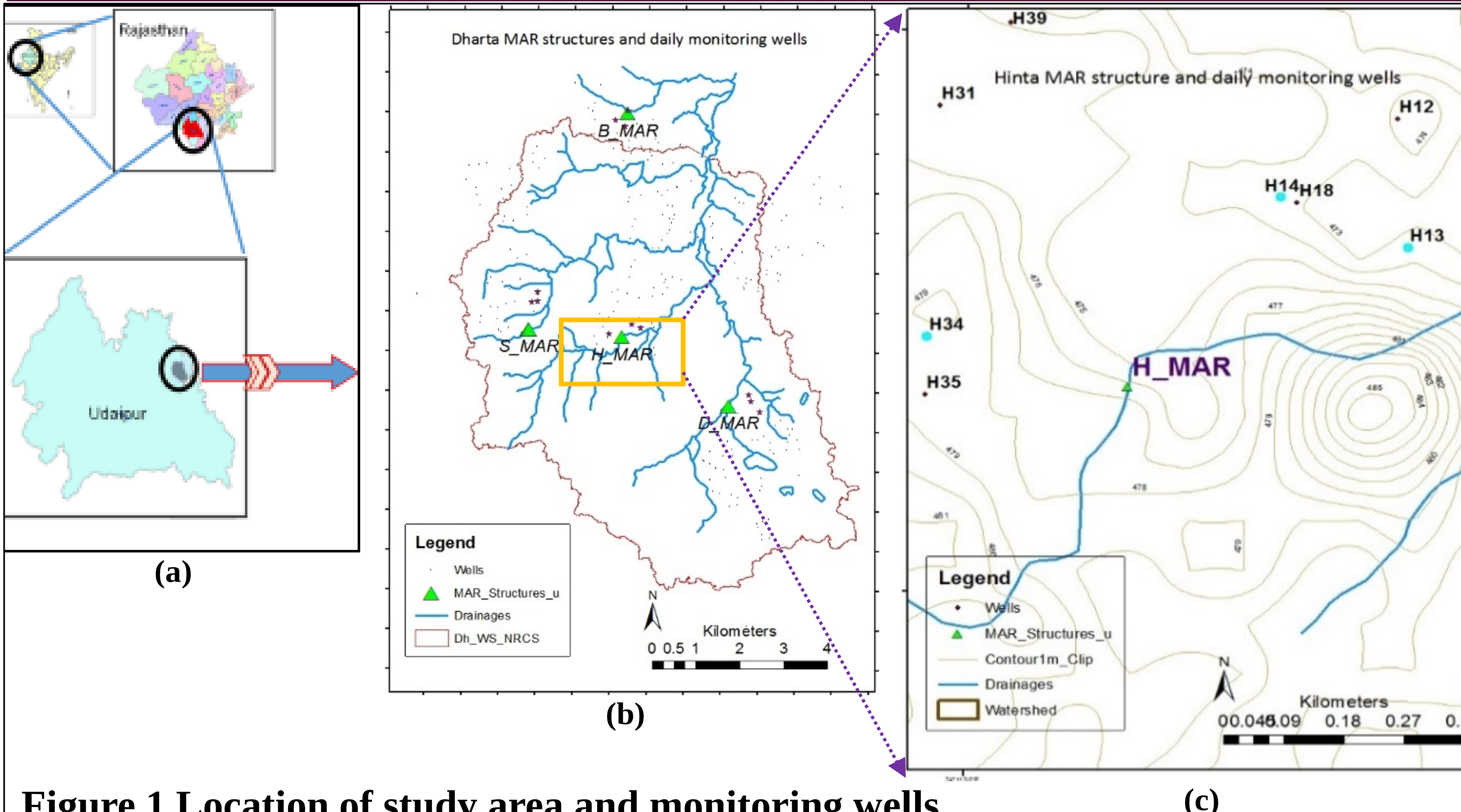
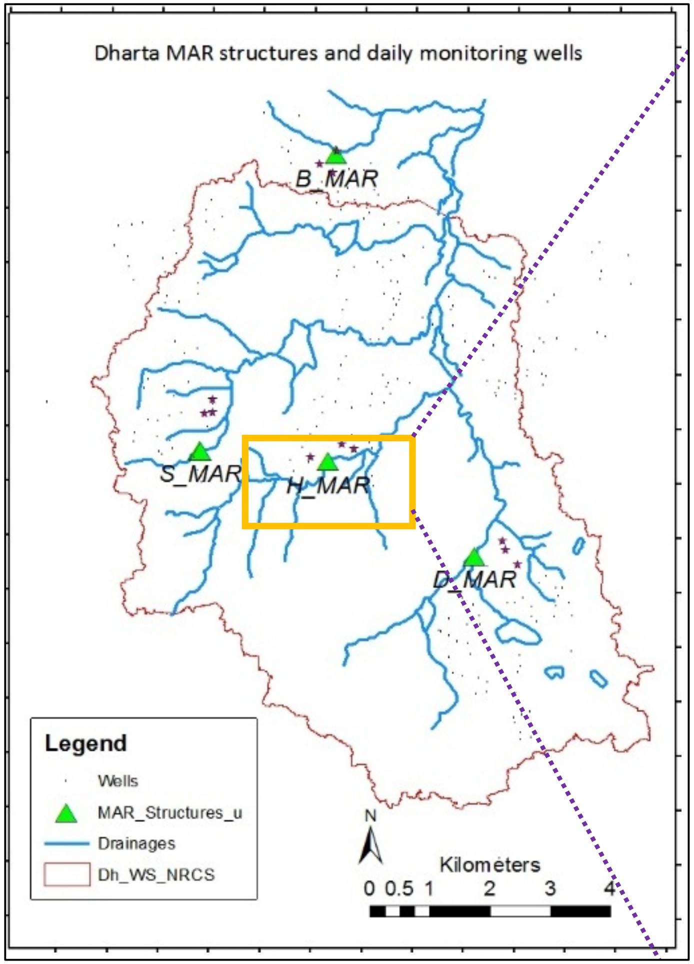


Figure 1 Location of study area and monitoring wells

STUDY AREA

- The average annual rainfall is 665 mm. The temperatures in the area are in the range between 19° to 48° centigrade during summer and 3° to 28° centigrade during winter.
- Monsoon season June to September.
- Thickness of the upper soil surface is one meter with sandy loam texture with average 2% slope
- Underlying formation is Granite gneiss hard rock up to 28m depth
- Irrigation is entirely dependent on Groundwater



STUDY AREA (Contd…)

- an over-exploited block of Udaipur;
- In the Dharta watershed four 4 check dams, one in each village viz. Badgaon, Dharta, Hinta and Sundarpura were selected.
- The water balance components were calculated for each check dam

METHODOLOGY

- **Selection of Groundwater Recharge Structures**
- **Field monitoring**
- **Catchment delineation**
- **Water balance analysis**

SELECTION OF GROUNDWATER RECHARGE STRUCTURES

	Recharge structure	Total depth, m	Water spread area, m^2	Capacity, m^3	Catchment Area, Ha	Check dam area as % of catchment	Check dam Capacity as mm over catchment
1	Badgaon	1.57	39,000	*42,000	338	1.15	12.4
2	Dharta	1.82	136,600	**140,000	1705	0.80	8.2
3	Hinta	2.62	127,200	**223,000	851	1.49	26.2
4	Sunderpura	2.05	62,800	64,400	109	5.77	59.1

FIELD MONITORING:

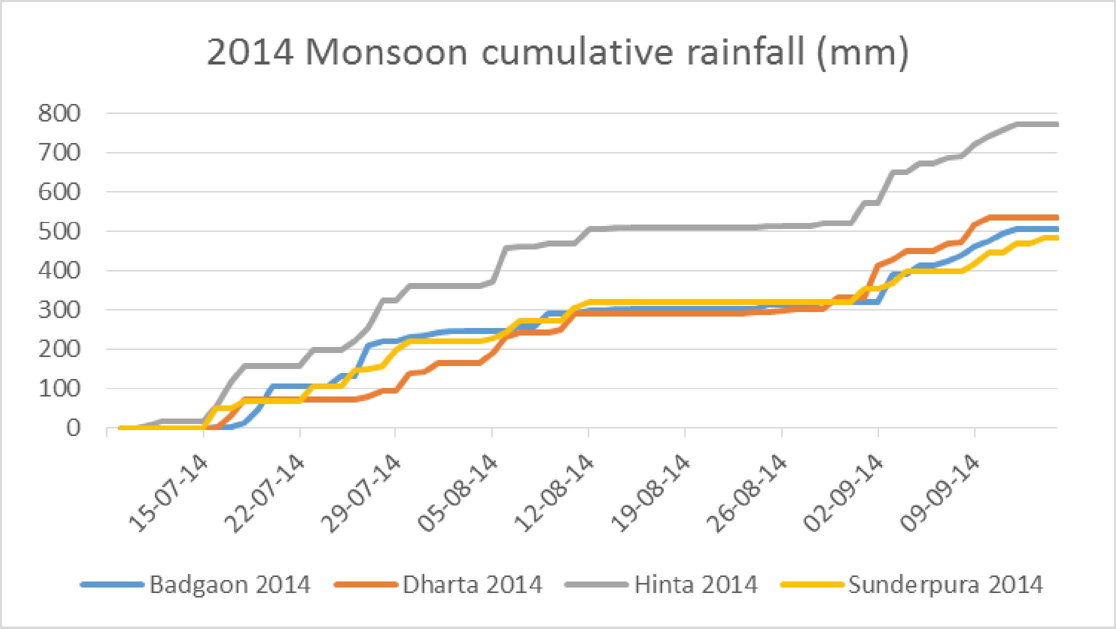
- Level surveys were carried out on each check dam for calculating water spread area and area- elevation curves.

CHECK DAM
WITH GAUGE BOARD

FIELD MONITORING: (i) Water level in Anicut: Daily basis

(ii)Rainfall: Daily basis

- The rainfall data was been recorded on a daily basis using semi-automatic tipping bucket type, ordinary rain gauges and Automatic weather station.
- The rain gauges were installed around1km distance from structures.



Tipping bucket Rain gauge

CATCHMENT DELINEATION & DATA ANALYSIS

- The area contributing water to each structure was delineated using Arc-GIS, Arc-SWAT software.
- The semi-automated watershed delineation approach was used for catchment delineation.

Area-volume calculations

- The area of ponded water was calculated by making contours from dumpy level/total station survey data. Area of contour was calculated using graph and Planimeter. The volume entrapped between contours were calculated by Trapezoidal Rule and cone formula.

$$Trapezoidal\ Rule; \qquad V = \frac{1}{6} \times (A_0 + 4A_m + A_t) \times (RL_t - RL_0)$$

$$Cone\ formula; \qquad V = \frac{1}{3} \times A_0 \times h$$

WATER BALANCE COMPONENTS

- In this study, water stored in the check dam is not pumped for irrigation or any other purpose and therefore the alteration in volume was considered due to infiltration and evaporation.

The water balance can be written as:

(Inflow)- (Losses) = (Change in storage)

So

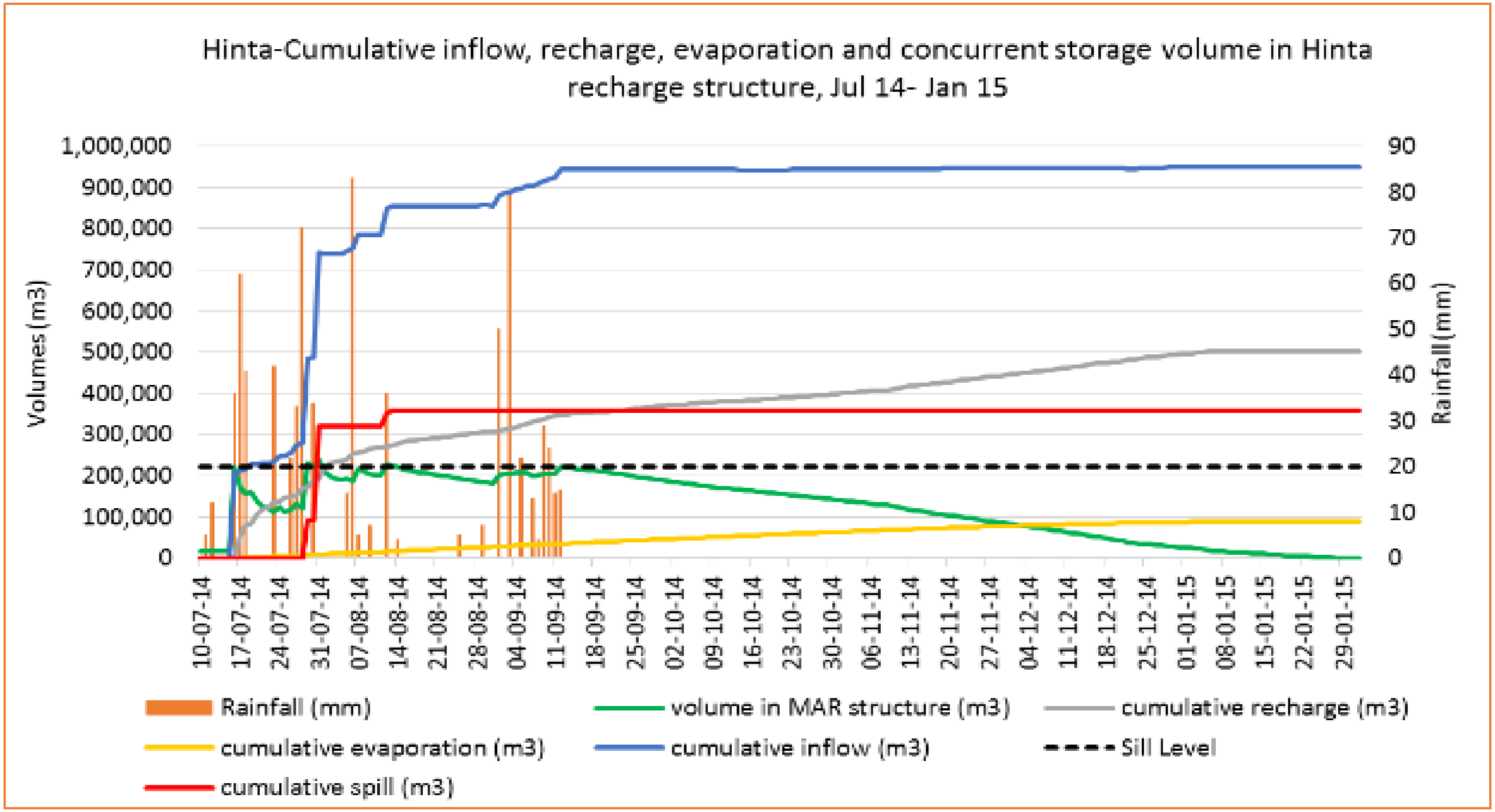
Inflow = Rainfall and Runoff

Losses= Evaporation and infiltration

In dry weather water level decline = Infiltration +Evaporation

Mean Dry Weather Infiltration Rate (DWIR) was assumed to apply during wet weather.

WATER BALANCE AT HINTA CHECK DAM: 2014



WATER BALANCE SUMMARY

Village	Year	Rainfall, mm	Total Inflow, m3	Total Recharge, m3	Total Spill, m3	Total Evapor-ation, m3	Total Recharge/ Total Inflow, %	Total Recharge/ Capacity
Badgaon	2014	505	349,000	113,000	218,000	19,000	32%	2.86
	2015	614	189,000	56,000	129,000	4,700	27%	1.34
	2016	1161	1,145,000	143000	980,000	26,000	12%	3.4
Dharta	2014	535	1,312,000	299,000	954,000	64,000	23%	2.19
	2015	596	192,000	157,000	0	44,000	81%	1.12
	2016	1151	6,502,000	180000	6,228,000	94,000	2.8%	1.27
Hinta	2014	771	949,000	518,000	358,000	91,000	55%	2.32
	2015	673	331,000	286,000	0	63,000	86%	1.28
	2016	1387	750000	388000	246,000	115,000	52%	1.48
Sunderpura	2014	485	54,000	46,000	0	8,000	85%	0.71
	2015	406	13,000	11,000	0	1,600	88%	0.17
	2016	1069	360000	139000	177,000	44,000	39%	2.16
Mean or Total		**643.5**	**12,146,000**	**2,336,000**	**9,290,000**	**574,300**	**19%**	**1.66**

Effect of desilting on recharge

One of the rainwater harvesting structure at Meghraj watershed. The right side of the structure is meant for storing the harvested water but due to some poor design the structure is filled with soil.

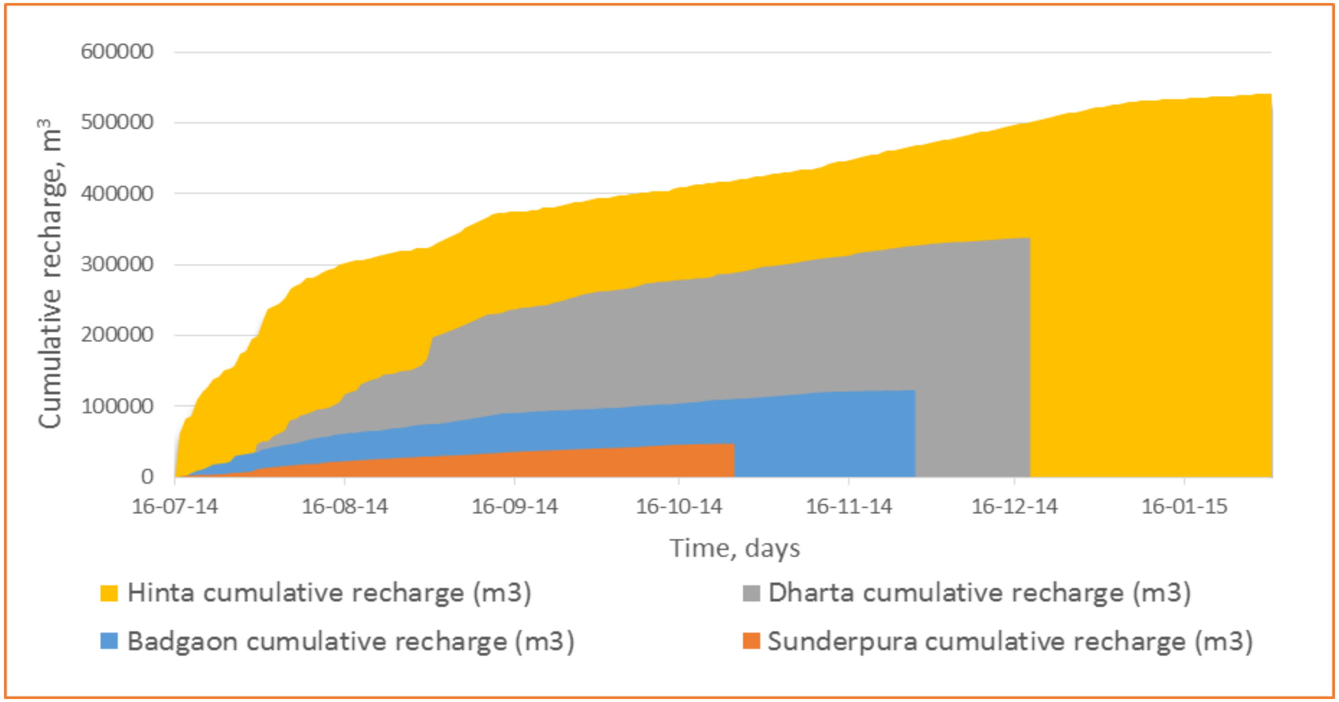
desilting

	Mean Dry Weather Infiltration Rate (mm/d)			
Check dam	**2014**	**2015**	**2016**	**3 years**
Badgaon	31	***57***	29	**39**
Dharta	22	***18***	**10**	**17**
Hinta	26	26	**18**	**23**
Sunderpura	28	35	19	**27**
Mean	**27**	**34**	**19**	**27**

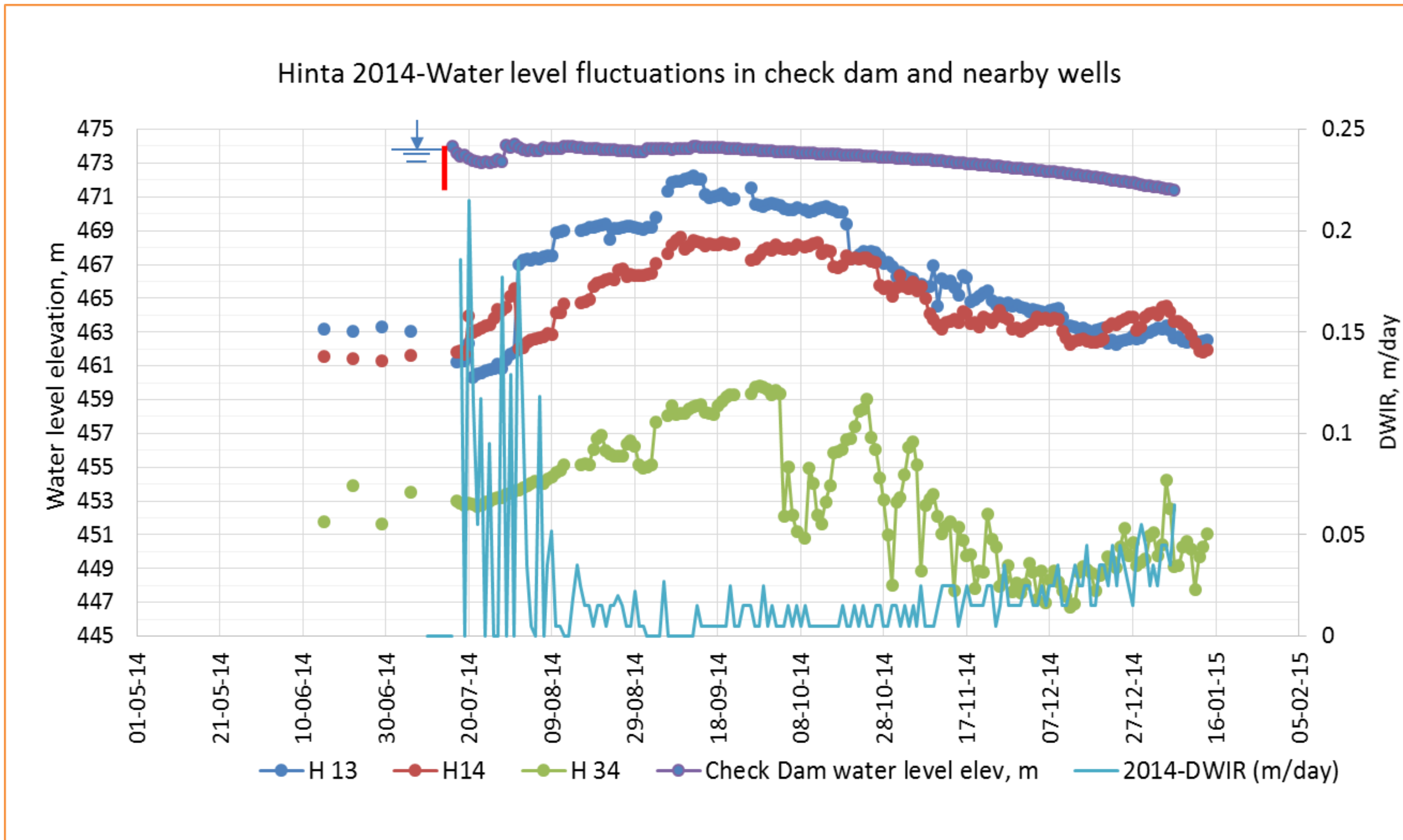
- Ave check dam capacity/ catchment area = 16mm (8-59mm)
- Ave annual recharge/checkdam capacity = 1.66 (1.00 – 2.02)
- Ave annual recharge / catchment area = 26mm
- Ave annual recharge = 4 x evaporation loss
- Ave annual recharge = 779,000m^3 (510,000 – 976,000 m^3)
- **Supports 195 Ha irrigation = 16% rabi production**

COMPARISON OF DIFFERENT RECHARGE SITES

- As illustrated in Figure the recharge capacity of different structures varies from 47000 to 540000 m^3.
- Hinta structure induced max recharge
- Hydraulic loadings : varies significantly

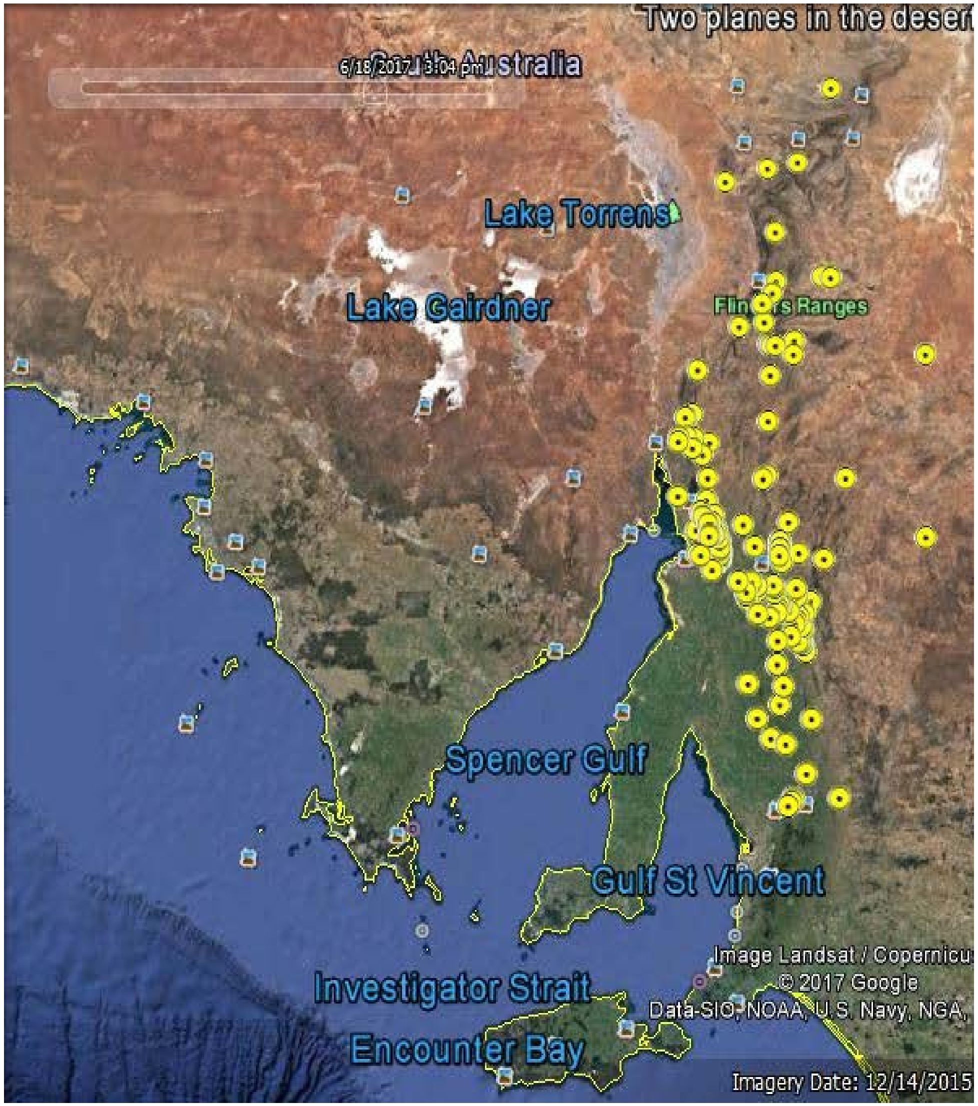


INTERACTION BETWEEN SURFACE AND GROUNDWATER



CONCLUSIONS OF THE STUDY

- Farmers took daily measurements of rainfall, and water levels in check dams and nearby wells to enable recharge to be evaluated
- Their data enabled water balances to be estimated for 4 check dams over 3 years.
- These revealed infiltration rates of 5 to 8 times the evaporation rate and recharge between 12 and 88 % of runoff.
- Manual desilting increased infiltration rates. Following mechanical desilting infiltration rates reduced.
- Check dams contributed 16% of water used for irrigation in the rabi season
- Modelling studies are planned along with further field investigations to enable improved design, placement and policies for stream bed recharge structures in hard rock catchments.



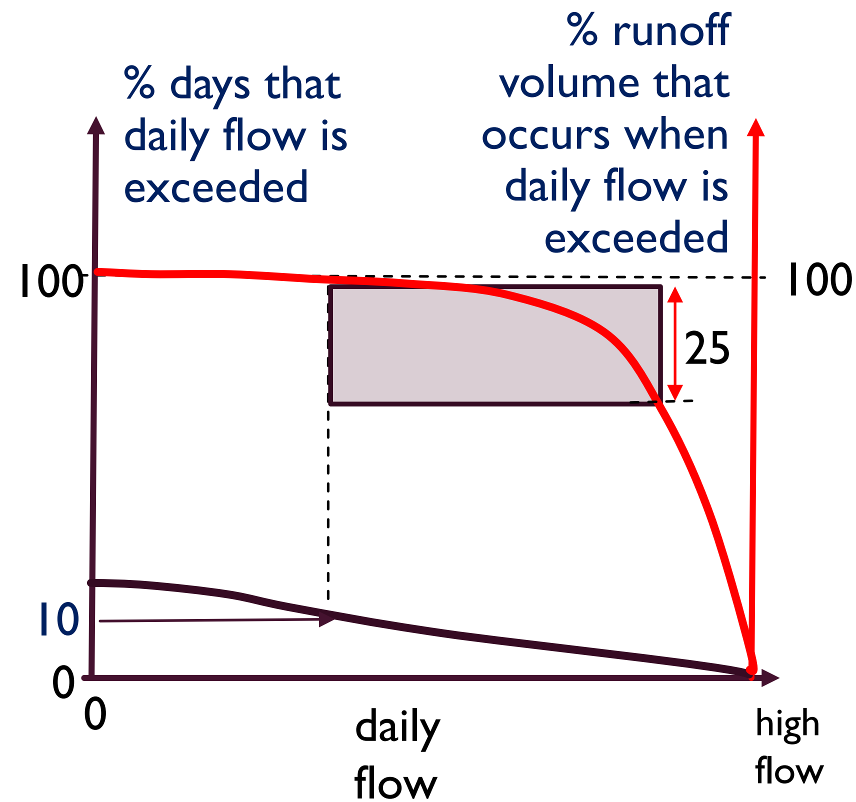
South Australian wells in northern corridor project. Data provided by SA Dept for Environment, Water and Natural Resources (DEWNR)

Marked wells :

- maximum depth < 30m
- TDS < 2000 mg/L
- yield >1 L/sec, and
- Not within a prescribed area
- Prospective areas for streambed recharge structures, if near streams, economic, suitable shallow aquifer exists and environmental flows can be sustained.

MAR AND ENVIRONMENTAL FLOWS – IN SOUTH AUSTRALIA

- building a dam on a stream is a water-affecting activity and needs a permit;
- not more than 25% of pre-development flow in a catchment to be captured;
- no harvesting of baseflows;
- off-stream storages only unless not possible and can demonstrate achievement of environmental flows if built on-stream;
- harvestable flow is only that within the upper ten percentile of flows and then only 50% of mean annual volume harvestable, although dam capacity may be up to twice this volume.



RELEVANCE OF CHECK DAMS TO SOUTH AUSTRALIA

- Suitable sites are likely to exist outside of prescribed areas
- Evaluation of environmental flows necessary to determine opportunities
- Site specific evaluations then warranted to determine if economic
- Use of models such as WaterCress are essential to these studies
- The SA experience with farm dams policy development using WaterCress modelling will be valuable in India to determine downstream impacts of check dams for whole of catchment water management.

ACKNOWLEDGEMENTS

- **This visit was funded by International Centre of Excellence in Water Resources Management (ICE-WaRM).**
- **Thank you Flinders University for hosting me.**

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Thanks to my College and University: CTAE, Maharana Pratap University of Agriculture and Technology (MPUAT) for allowing me for fellowship visit.

THANK YOU

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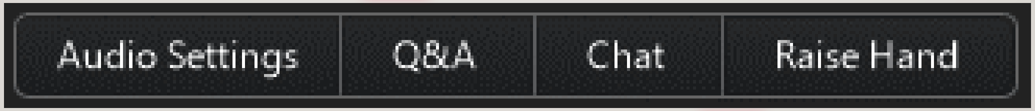
LOGISTICS FOR Q&A

1. Please click **Q&A** and type your question:



2. Please click **raise hand** and ask a **live** question on screen.

THANKS FOR PARTICIPATING

REMINDER:

- FEEDBACK: complete short survey as you close this window.
- RECORDING: link will be emailed
- FREE WEBINARS:
  - **Thurs 29th June 2017: Next Generation Irrigation Management**: *Tim Hyde, Ivor Gaylard*
  - **Thurs 6th July 2017: MAR for Water Utilities:** *Greg Ingleton*
  - **Thurs 27th July 2017: Community Wastewater Reuse with HRAP #2**: *Howard Fallowfield*
  - **Thurs 31st Aug 2017: Water Research Australia:** *Peter Brass*
- TWITTER: **@ICE_WaRM_** keep up-to-date with ICE WaRM