

# *Ground Water Recharge and Water Table Simulation In Irrigation Command*



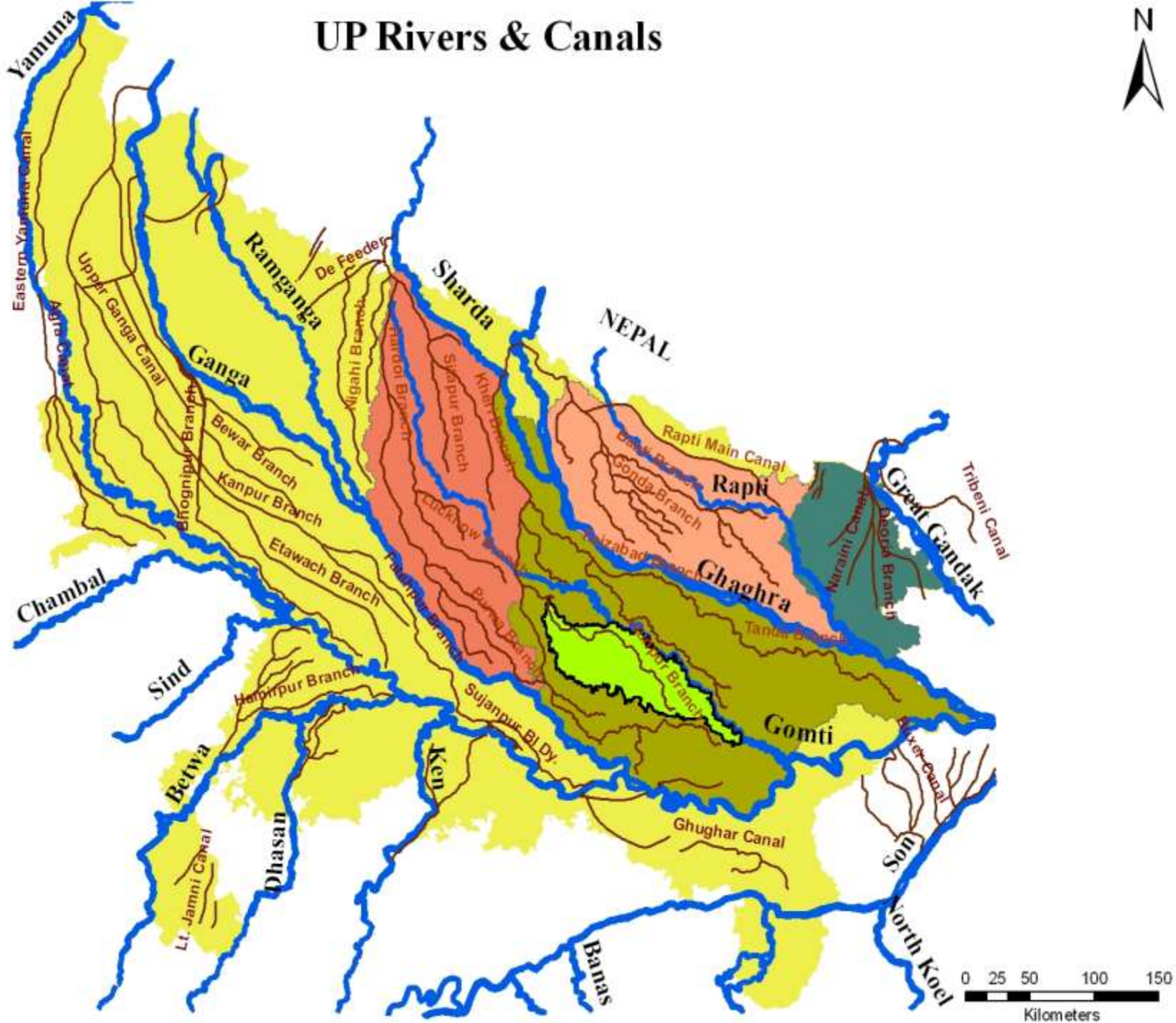
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Ashok Raut

# UP Rivers & Canals



## Legend

- Rivers
- UP\_Canal
- UP Boundary
- Main
- Branch
- GGB Canal System
  - Gandak
  - Saryu
  - Sharda
  - Sharda Sahayak
  - JBS\_Boundary



# Groundwater Recharge from Canal Network

Canal System in Uttar Pradesh 73,000 km

Irrigation Potential Created 85 lakh ha

## Study Area: Gomti–Sai River Basin

Jaunpur Branch Sub Basin of Sarda Sahayak Canal

GCA 5.42 lakh ha

CCA 2.40 lakh ha

Main Canal Capacity 121 cumec

Length of main canal 120 km

## Canal System Water Losses (as % of supply)

Main/Branch Canal	4
Distributaries & Minors	5 to 8
Field Channel	25
Field Operation	30 to 35
Canal irrigation efficiency-	30 to 35

(GEC, 97): Seepage Losses from unlined canal

Normal soil: 1.8 -2.5 m<sup>3</sup>/s/m sqm of w.p.

Sandy soil: 3.0- 3.5 m<sup>3</sup>/s/m sqm of w.p.

# **Factors determining the amount of seepage**

Soil characteristics and its permeability;

Geometry and hydraulics of the canal;

Climatic Conditions

Sediment deposition and velocity of flow

## **Formula used**

Davis & Wilson , USBR, USA Design Directives,  
Egyptian ID, Punjab I & II, UPID formula

# Groundwater Assessment in JBSB Irrigation Gross Command

Total Groundwater recharge = 3268 mcm

Recharge from rainfall = 1939 mcm

Recharge from other sources = 1329 mcm

Canal seepage 527 mcm

Return flow from irrigation

Surface 282 mcm

Ground 484 mcm

Recharge from other measures 36 mcm

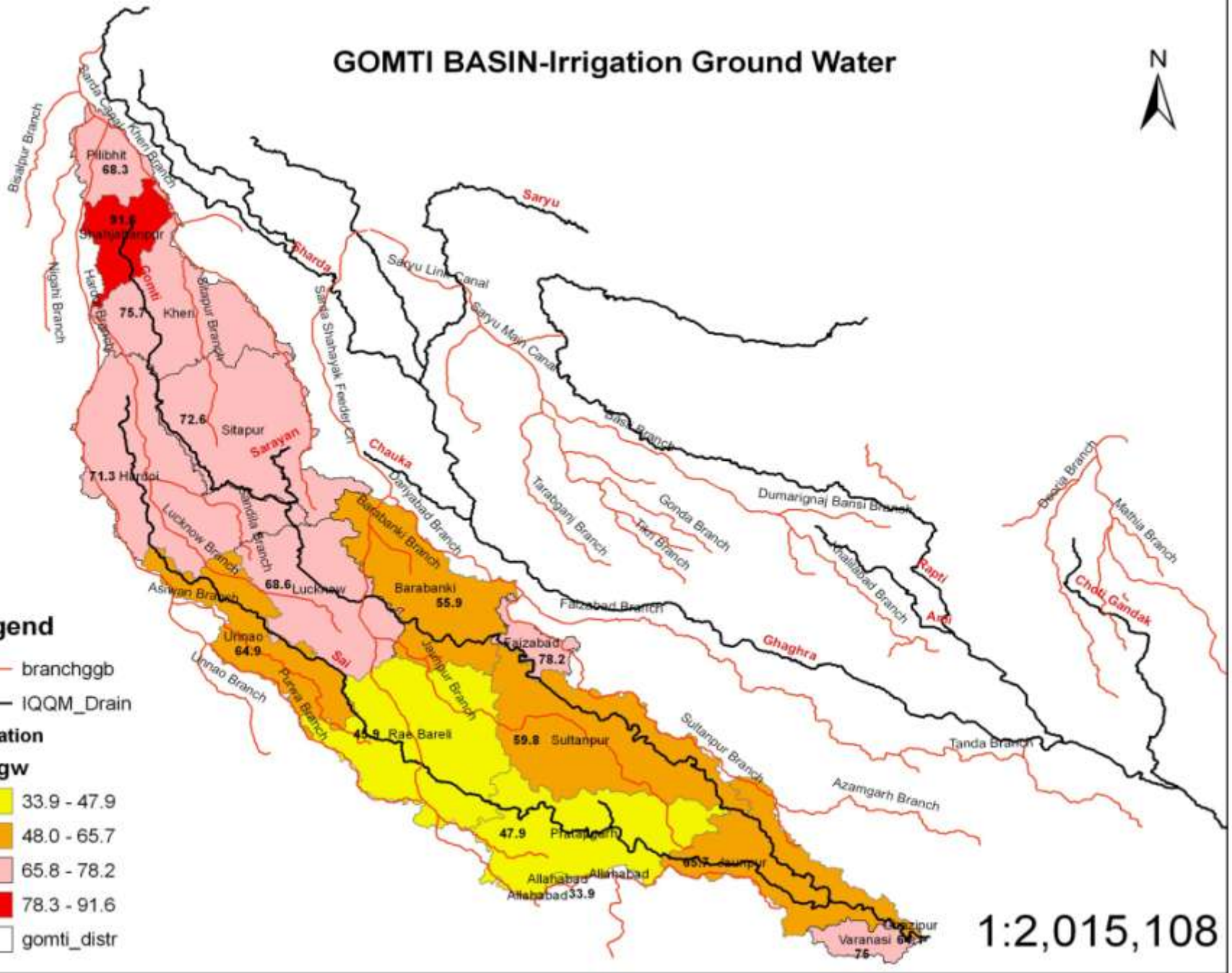


# GOMTI BASIN-Irrigation Ground Water



## Legend

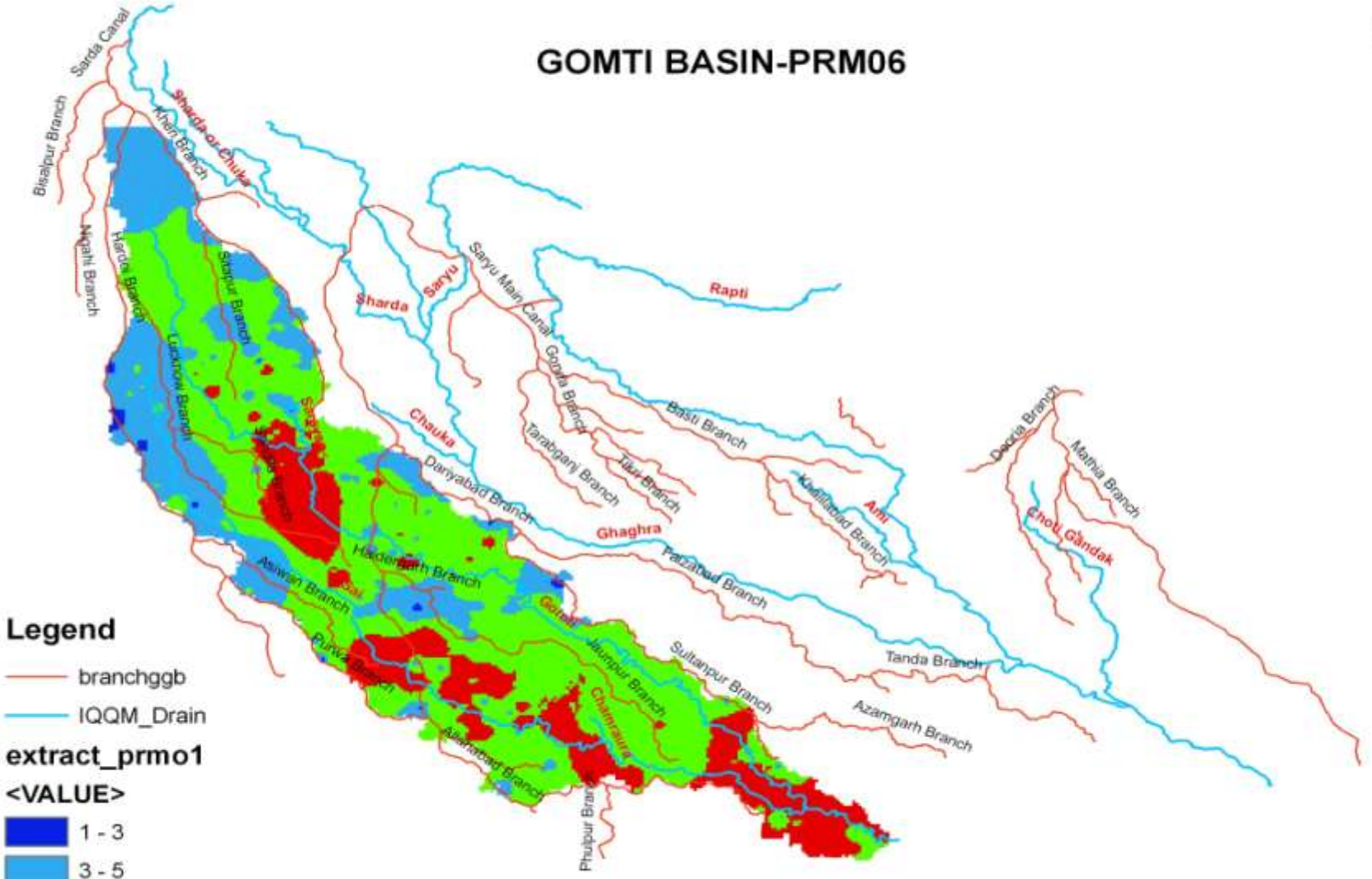
- branchggb
- IQQM\_Drain
- irrigation**
- Irr\_gw**
- 33.9 - 47.9
- 48.0 - 65.7
- 65.8 - 78.2
- 78.3 - 91.6
- gomti\_distr



1:2,015,108



# GOMTI BASIN-PRM06



## Legend

- branchggb
- IQQM\_Drain

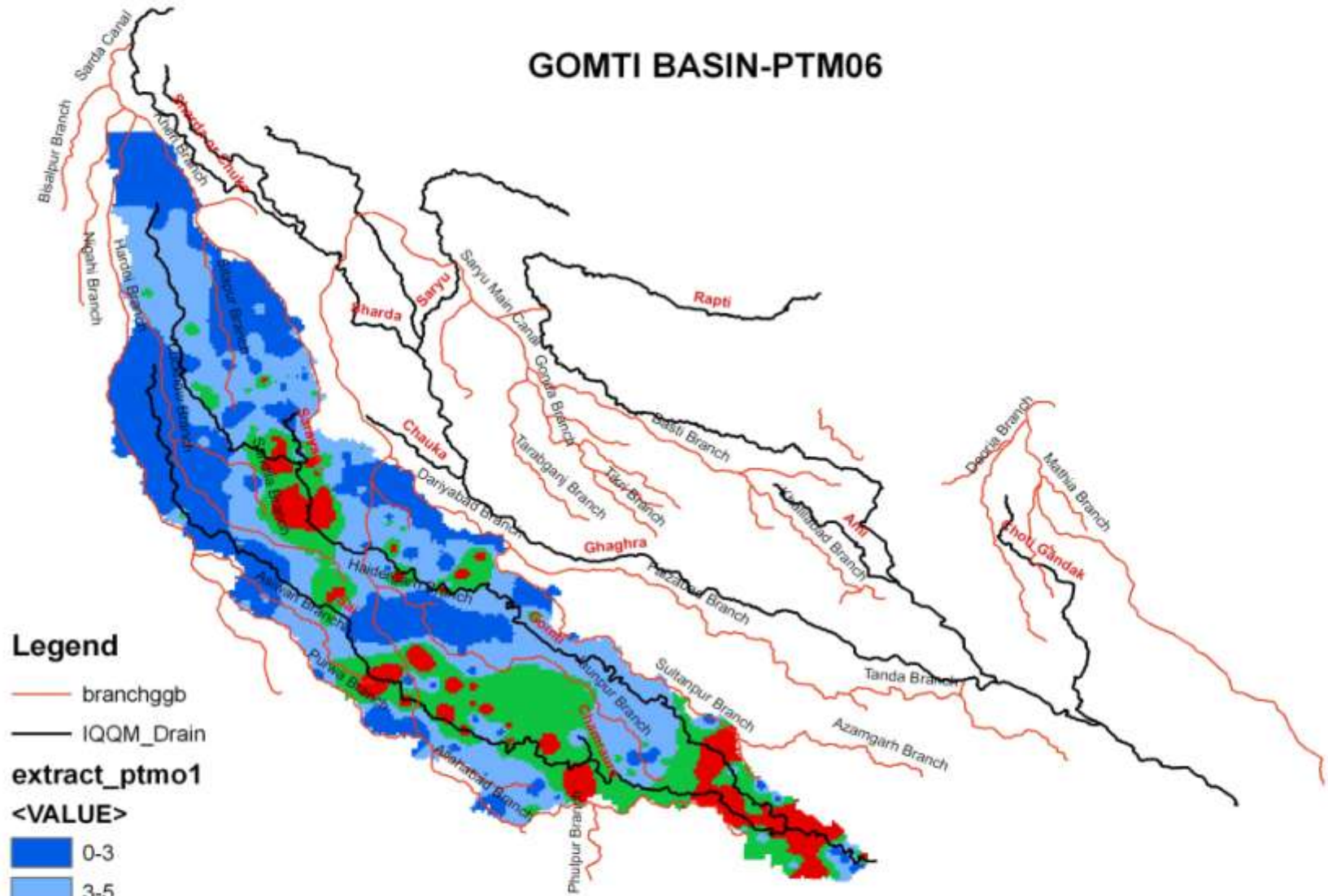
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3 - 5
5-8
8-15

1:2,518,885



# GOMTI BASIN-PTM06



## Legend

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- IQQM\_Drain

extract\_ptmo1

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- 3-5
- 5-8
- 8-14

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# Simulation Study in JBSB

Case-1 Business as usual: Canal running as in practice now i.e. Direct outlets on main canals & flood irrigation practice

10 years weekly simulation June 1997 onwards shows that

**Groundwater table rising critically**

Depth to Groundwater (m bgl)

17-Jun-97  
4-Nov-97  
24-Mar-98  
11-Aug-98  
29-Dec-98  
18-May-99  
5-Oct-99  
22-Feb-00  
11-Jul-00  
28-Nov-00  
17-Apr-01  
4-Sep-01  
22-Jan-02  
11-Jun-02  
29-Oct-02  
18-Mar-03

*Scenario: Current management practice (direct outlets open, groundwater not preferred) with current cropping intensity (~150% rice-wheat)*

*Groundwater table rising critically*



Case-2 Canal Running (seepage allowed)  
but direct outlets closed (surface  
irrigation not allowed) and irrigation  
through groundwater resource

10 years weekly simulation June 1997  
onwards shows that

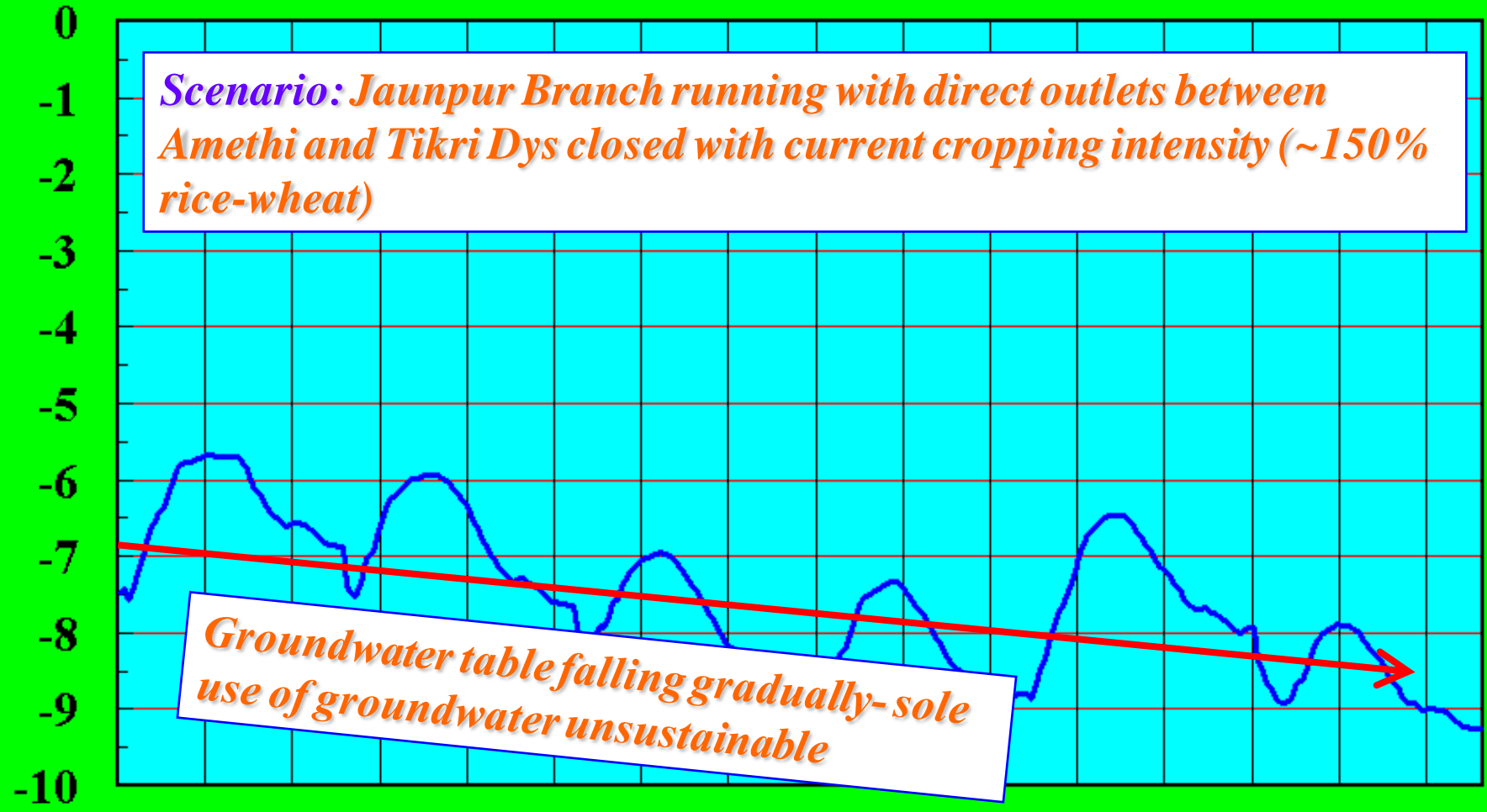
**Groundwater table declining critically**

Depth to Groundwater (m bgl)

17-Jun-97  
4-Nov-97  
24-Mar-98  
11-Aug-98  
29-Dec-98  
18-May-99  
5-Oct-99  
22-Feb-00  
11-Jul-00  
28-Nov-00  
17-Apr-01  
4-Sep-01  
22-Jan-02  
11-Jun-02  
29-Oct-02  
18-Mar-03

*Scenario: Jaunpur Branch running with direct outlets between Amethi and Tikri Dys closed with current cropping intensity (~150% rice-wheat)*

*Groundwater table falling gradually- sole use of groundwater unsustainable*



Case-3 Main Branch Canal  
Closed and irrigation through  
groundwater resource

10 years weekly simulation  
June 1997 onwards shows that  
**Groundwater table declining  
critically to unsustainable  
limit.**

Depth to Groundwater (m bgl)

17-Jun-97  
4-Nov-97  
24-Mar-98  
11-Aug-98  
29-Dec-98  
18-May-99  
5-Oct-99  
22-Feb-00  
11-Jul-00  
28-Nov-00  
17-Apr-01  
4-Sep-01  
22-Jan-02  
11-Jun-02  
29-Oct-02  
18-Mar-03

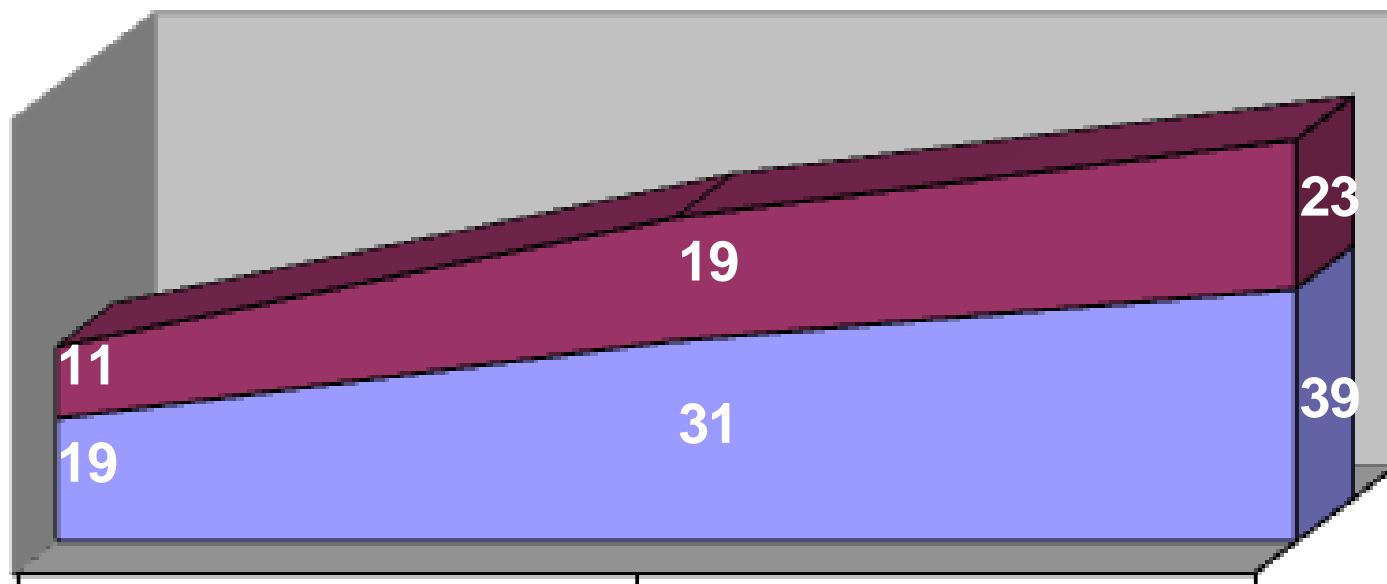
*Scenario: Jaunpur Branch closed with current cropping intensity (~150% rice-wheat)*

*Groundwater table falling rapidly - not enough groundwater*



Need of Conjunctive Use of SW & GW

## An Example from Sharda Sahayak Project



As Design (Project)

As Existing

Anticipated

■ Area Irrigated ( mha.)

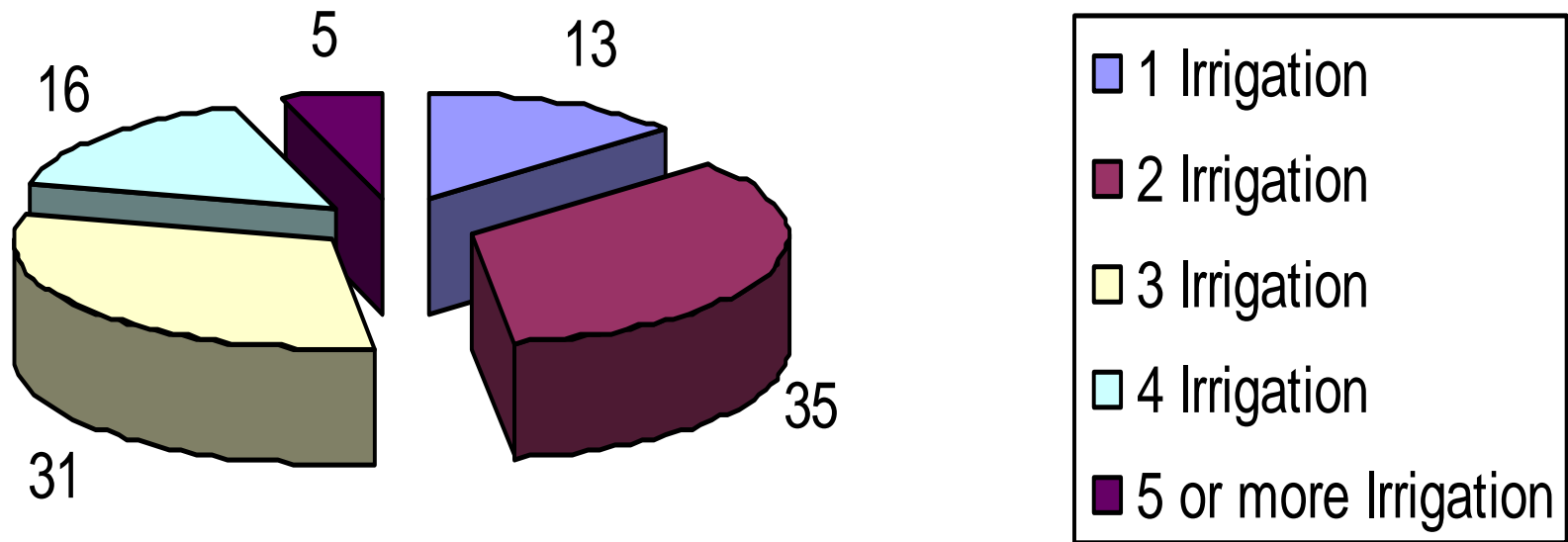
■ Water Requirement (m cubic m)

# Percentage Area Distribution

Number of Irrigations For Wheat in Sharda Sahayak Project

Average no. irrigation 1982-83 2.6

Average no. irrigation 1992-93 2.9



# Case-4 : Conjunctive Use

Cropping Intensity Changed from present 150% to 230%

Use both canal and Groundwater

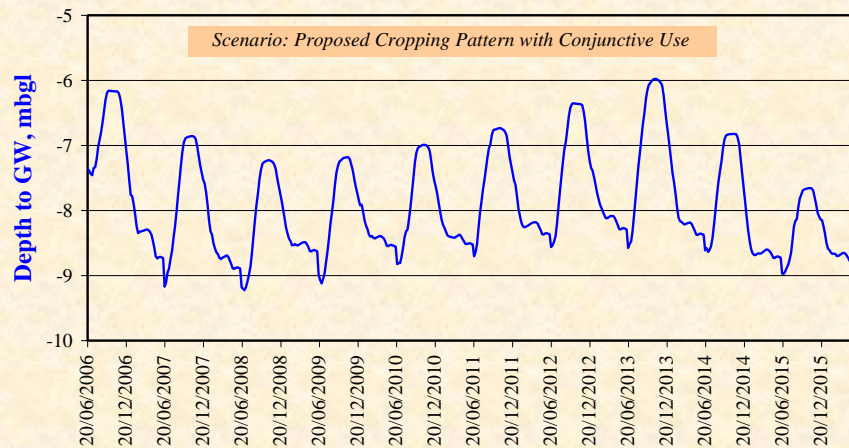
Simulation results shows that groundwater table fluctuating between 6 to 9 mbgl and stabilizing at around 8 mbgl

indicate sustainability of GWR use

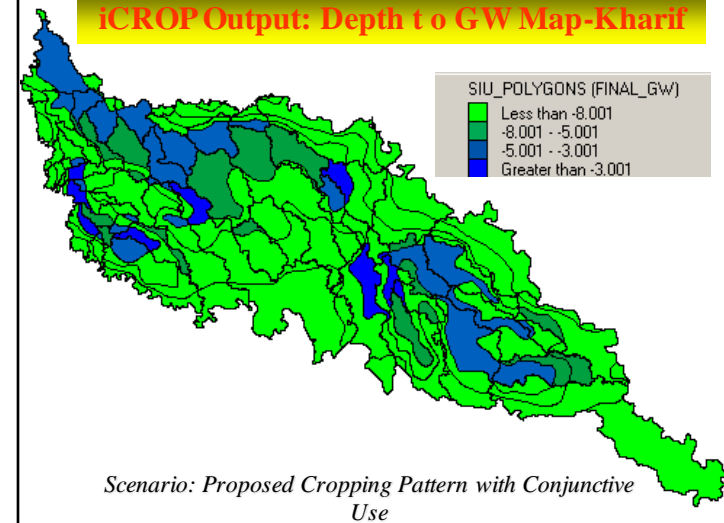
## TYPICAL APPLICATIONS OF JBS DSS

The task of computing and presenting outputs in a comprehensible manner becomes increasingly difficult for a decision-making (what-if scenario) involving integrated water resource management (IWRM) without any computer software package. The JBS DSS contains a computer model, iCROP, that can be used to compute crop water requirement, allocate resources, groundwater profile, socio-economic value of a decision etc. For example, a planner has to investigate if available water resources in JBS are adequate enough if the cropping intensity is increased from currently about 150% to 230% and conjunctive water management policy is adopted. The 10-year weekly simulation of depth to groundwater evidently suggests that such resources use is sustainable and consequently, the groundwater profile will also improve significantly.

### 10-yr Weekly Simulation of Depth to GW



### iCROP Output: Depth to GW Map-Kharif



# Discussion of Simulation Results

- Scenario-1 : Only Canal Irrigation allowed  
for cropping intensity of 150%
  - the rising water table observed @ 0.5 m/yr
  - and the tail commands remain un irrigated  
where water table is often found deep.

Scenario-2: Only Seepage allowed by running canals but outlets closed & Groundwater Irrigation allowed

Then ground water table decline rate is noticed @ 1m/ year

.

Scenario-3 If Canal is closed and Only Groundwater irrigation allowed

rate of decline of water table is found to be @ 2m/ year.

## Scenario-4 Conjunctive Use of Canal and GW for CI = 230%

The groundwater table would remain within the limits of 6 to 9 mbgl

### **Benefits: Farm Produce**

Gross margin will increase from 9,000Rs/ha to 18,000 Rs/ha

# GW Recharge in Gomti-Sai Basin

Check Dams (No.)	Ponds (No.)	Estimated Recharge ha.m/yr			Total Estimated Recharge (MCM)	Recharge depth (mm)	Recharge depth on developed area
		Ponds	Check Dams	Roof Top Rainwater Harvesting			
16931	84647	16929	3386	103	204	0.84	16.8

# Impact of Canal Seepage in Gomti-Sai Basin

<b>Seepage depth on CCA (mm)</b>	<b>Seepage depth on Topographical area (mm)</b>
<b>58.26</b>	<b>29.47</b>

# Conclusion

Canal seepage if managed properly would provide the best way of water harvesting for rural areas.

Aquifer management is equally important having withdrawal from varying depth for varying discharges.

Water harvesting and rainfall recharge should be business of every body.

Thank You