CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING:

CEWRE AND GROUNWATER GOVERNANCE IN ASIA

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CEWRE AND GROUNWATER GOVERNANCE IN ASIA

- The CEWRE was established in 1976 to undertake post graduate studies and high-level, goal-oriented research in the water resources sector in Pakistan.
- It is imparting Ph.D./ M.Phil./ M.Sc. degrees in the disciplines related to quantification, harnessing, development and management of water resources (both surface and groundwater resources).

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- Centre arranges seminars, symposium and short term training courses in various fields.
- Centre has also provided advisory role for other institutions
- Applied research is conducted by Centre faculty and students in various fields

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The groundwater governance requires the working knowledge in respect of

i). Understanding concepts of groundwater hydrology,

ii). Quantification of groundwater resources (including water budget) and their spatial and temporal distribution,

iii). Quantification of the interactions and properties of the groundwater reservoir, i.e. the aquifer,

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iv). Design of groundwater extraction mechanism including pumping machinery, skimming wells, etc.

v). Modeling of aquifer system(s) to visualize complex spatial and temporal interactions in respect of recharges and discharges, rise-fall of ground water levels, implications of alternate governance protocols.

vi). Modeling of groundwater aquifer for changes in groundwater quality concerns, including lateral and upward intrusion of poor quality waters into the fresh water reserves.

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The studies carried out in the past related to groundwater include:

- 1986. Statistical curve fitting methods applied to groundwater pumping test analysis.
- 1987. Evaluation of aquifer parameters using sensitivity analysis method.
- 1987. Three dimensional modeling of groundwater flow (conduit analogue).
- 1987. Pumping test analysis using numerical method.

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- 1988. A linear programming model for designing optimal cropping pattern with conjunctive use of surface and groundwater.
- 1988. Numerical simulation of a partially penetrating well in confined aquifer.
- 1989. Trends and causes of changes in chemical quality of groundwater in SCARP-I.
- 1990. A model for parameter evaluation of confined aquifer.
- 1991. Geostatistical modeling to quantify the transmissivity field in an aquifer.

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- 1994. Groundwater flow modeling of the Lahore city and surroundings.
- 1995. Application of electrical resistively method for the assessment of groundwater quality.
- 1996. Evaluation and improvements in SCARP-I Transition program.
- 1997. Mobility of pollutants to groundwater at various disposal sites in Lahore.
- 1999. Development of freshwater skimming well technology for sustainable irrigation and drainage.

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- 1999. Tubewell development criterion for saline groundwater using a numerical model.
- 1999. Development of groundwater management strategies based on Islamic principles.
- 2000. Study of upcoming of fresh and saline groundwater interface under scavenger well.

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- 2000. Impact of Scarp transition and sustainability of community tubewells in selected areas of SCARP-I.
- 2002. Application of Modflow numerical model in Pir Mahal area of Rechna doab.
- 2002. Suitability of shallow skimming wells for sustainable groundwater management in Lower Indus Basin of Pakistan.

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- 2003. Prospectus of ever-increasing tubewell irrigation on drought mitigation.
- 2004. Impacts of irrigation intensification on the groundwater regime in Bannu Plain.
- 2005. Evaluation of sustainability of irrigated agriculture in Spaira Ragha Plain of North Waziristan Agency.

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- 2005. Integerated Water Resources Management for Sustainable Development. (Dr. Muhammad Latif, PI.) 2004-2006.

Summary of few studies in as under

APPLICATION OF MODFLOW NUMERICAL MODEL IN PIR MAHAL AREA OF RECHNA DOAB

- Several SCARPs were implemented in the country in the sixties to curb twin menace of waterlogging and salinity.
- These projects successfully lowered the watertable as well as created an awareness with regard to development of tubewells in the private sector.

APPLICATION OF MODFLOW NUMERICAL MODEL IN PIR MAHAL AREA OF RECHNA DOAB

- Development of private tubewells in fresh ground water areas brought a revolution in irrigated farming by substantially increasing the cropping intensities and yields
- However unplanned and uncontrolled abstraction has finally lead to mining and salt water intrusion in some areas such as Pir Mahal in Rechna Doab.
- The groundwater in the area is declining by 0.6 to 1.6 m per year, necessitating deepening of pumping machinery and pumping from deeper depths at a substantial cost to the farmers.

A groundwater numerical model was formulated for the area to study and understand the future conditions in the area in terms of watertable depth and water quality.

- The model covered both the freshwater area of Pir Mahal and the saline groundwater area lying north-east of Pir Mahal. The model was calibrated for 10 years period, and later used to forecast impacts of different groundwater abstraction trends, meteorological conditions and development interventions.

- The results of the study revealed that watertable depth in FGW area south of Pir Mahal is continuously declining and the stress is ever increasing on areas already being mined.
- Groundwater flow from north-west part of the aquifer has also shown movement towards the critical area in south and south-west of Pir Mahal.
- Water quality data also confirmed deterioration of pumped water.

- In order to protect the fresh groundwater aquifer from being getting impaired or permanently lost and to ensure sustainable groundwater supplies, groundwater management measures in the area are absolutely required.

INTEGERATED WATER RESOURCES MANAGEMENT FOR SUSTAINABLE DEVELOPMENT.

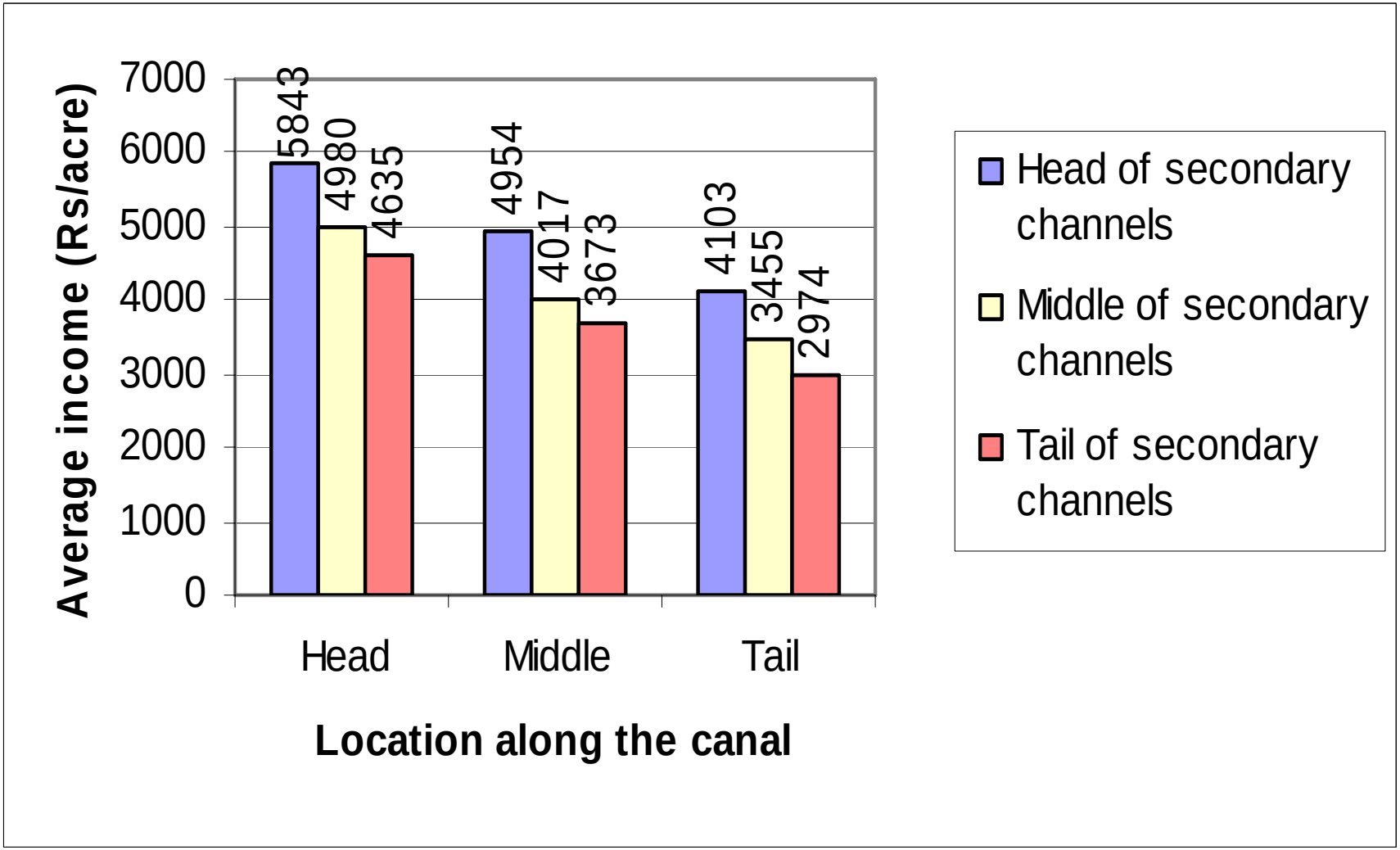
(Dr. Muhammad Latif, PI.) 2004-2007.

Tentative conclusions the study are summarized below. These conclusions will be further refined and confirmed from data for the next two years as the study is continued:

- There is clear trend of yield and income reduction along the tertiary (watercourse) as well as secondary channels (distributaries). Maximum income of Rs. 7155/- has been achieved at head of Ist distributary that decreased to Rs. 3225/- at the tail of the same watercourse (i.e. income of the head reach farmers is more than double of the income of tail end farmers at the head of the main canal).

- The net income not only decreases along the secondary channels but the difference in income of the head to tail reach farmers further increases. For example, the difference in income is more than double between the head to tail reach farmers whereas the same is tripled at the tail of Ist the distributary. The difference of income w.r.t. head of the 1st distributary varies from 85 to 51 percent on different distributaries (Fig. 1).

Fig 1: Average net income at head, middle and tail

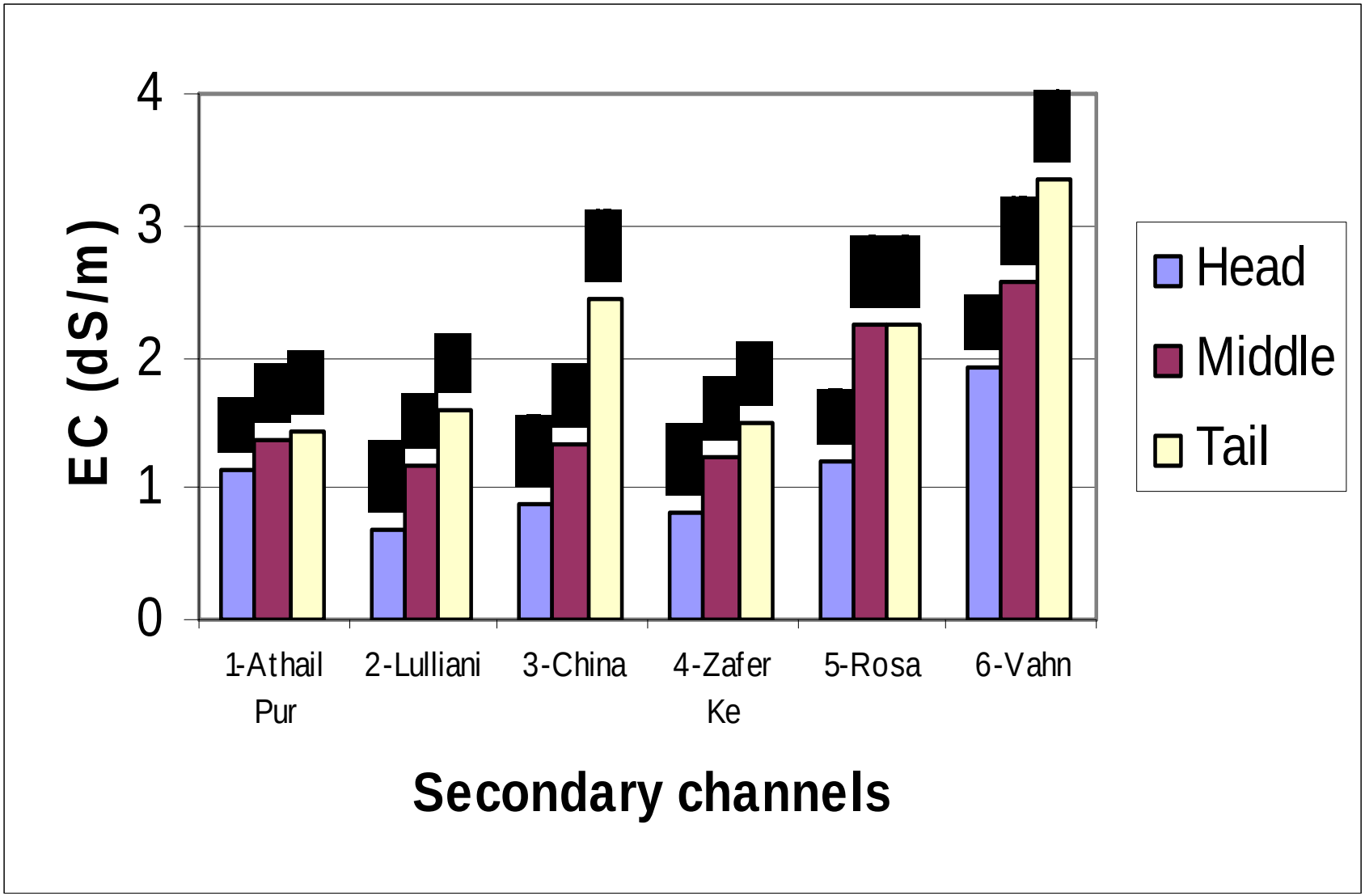


- Three to five irrigations were applied to the wheat crop. Normally all the irrigations at the heads of distributaries and watercourse are applied by canal water. But this number reduces to 1 or even to zero at the tail-ends of the watercourses located on the distributaries & minors situated at the lower reaches of the main canal.

- Cost of irrigation is proportional to the use of groundwater as the canal water charges (abaina) are fixed. Cost of irrigation per acres of wheat crop varies from Rs. 55 to more than Rs. 1500 for head to tail reach farmers.
- Maximum yield obtained in the canal command is 37 maunds per acre of grain wheat by a progressive farmer located at the distributary situated at the head of the canal. Difference in yield varies from 4-5 maunds per acre between the head and tail end farmers. Small difference in crop yield is due to the reason that the lower reach farmers use more groundwater to fulfill needs of their crops.

- Analysis of the groundwater quality data revealed that there is great variation of groundwater quality in the command area of the canal. The groundwater is generally suitable for irrigation in the command area of Ist four distributaries. Salt contents in groundwater increases in the command area of the last two distributaries. Furthermore, the groundwater quality normally deteriorates along the watercourses of all the distributaries (Fig. 2).

Fig 2: EC of Groundwater



- Average salinity of the soil profiles almost follows the same pattern as that of groundwater quality. The salinity of the soil profiles is low near the head of the watercourses and it increases towards the tail-ends of the watercourses. The profile salinity also increases along the distributaries particularly at the tails of the distributaries especially the last two.