CHAPTER 7

SUMMARY AND CONCLUSION

7.1 GENERAL

Even in water surplus areas agricultural drought is being observed in India due to the prevailing gap in supply and demand in irrigation water during crop seasons. The supply capacities of the existing irrigation canal systems are not adequate enough to cater the needs of the crop water requirements especially when the rainfall (crop season) of an area is below normal level. Regular growing of various weeds, silting, invasion of aquatic plants and more factors involve in affecting the functioning of the canal systems. To eradicate all these factors an effective Drought Management Plan is required. The following sections summarize various salient features of the study undertaken in that direction and its outputs.

7.2 SUMMARY

Water, a scarce resource, is the elixir of life. It is a natural resource, fundamental to life, livelihood, food security and sustainable development. United Nations has declared the decade 2005-2015 as International Decade for Action ‘Water for Life’. According to National Water Policy-2012 (Ministry of Water Resources, GoI, 2012), India has more than 17 percent of the world’s population, but has only 4% of world’s renewable water resources with 2.6% of world’s land area. There are challenges of frequent floods and droughts in one or the other part of the
country. Low consciousness about the scarcity of water and its life sustaining and economic value results in its mismanagement, wastage and inefficient use, as also pollution and reduction of flows below minimum ecological needs. In addition, there are inequities in distribution and lack of a unified perspective in planning, management and use of water resources.

Drought is a naturally recurring feature of climate which occurs in all climatic zones. The term drought refers to a constant reduction of water availability with respect to normal (mean) values. Drought can be assessed in meteorological, hydrological and agricultural aspects. Of these, rainfed agriculture is controlled by meteorological drought and the other cropped areas by agricultural drought. The specific objectives of the study are (i) to assess the agricultural drought severity using conventional demand-supply gap and remote sensing technique; and (ii) to analyse the drought vulnerability of irrigated agriculture.

Kanigiri reservoir command area, which is a part of Pennar delta, located in Nellore district in southern part of Andhra Pradesh, India is the area selected for this study. The area is not included in Drought Prone Areas Programme (DPAP) of Government of India as there were no frequent meteorological droughts in its history. But, prevalence of agricultural drought has to be studied as farmers suffer frequently due to failure of crops in different parts of the delta.

Agricultural drought severity assessment methods focus their attention mainly on micro-implications of agronomy of crops and not in quantification of water deficiency with respect to agricultural demand. In this study, an agricultural drought assessment methodology is developed based on supply and demand estimation. The agricultural drought assessment is carried out with the objective of estimating agricultural drought severity by employing the supply demand estimate.
The supply demand analysis was adopted on the basis of Rabi (November-March) and Early Kharif (April-August) seasons. The irrigation release from the channels and crop water requirement are considered as the supply and demand respectively. The requirement of water for the irrigated crop was estimated basically from the crop water requirement calculation.

The severity of agricultural drought could also be monitored through an understanding of vegetation status since the vegetation condition reflects the overall effect of rainfall, soil moisture, weather and agricultural practices. Here, an attempt is made to develop a Drought Severity Index (DSI) which involves crop area delineated from remote sensing data using NDVI analysis. Use of DSI for drought analysis is different from the use of rainfall analysis as the vegetation cover finds its presence in this index.

The total area under agricultural vegetation has been deciphered for the satellite images by eliminating the area under forest, barren lands and land put to non-agricultural usage. In eliminating these areas, different GIS layers have been used from the digitized landuse map of the study area. NDVI values have been generated for these satellite images which represent the area under agricultural vegetation using ArcGIS software package.

Technically, though all areas, sometime or other, suffer from crop losses and distress on account of drought, some clearly identifiable areas which have been subjected to frequent droughts have been characterized as drought prone areas and addressed by Drought Prone Areas Program (DPAP) in India. Identification of drought prone areas for inclusion and exclusion into/from DPAP has undergone considerable changes both in terms of agencies involved and the objectives followed. Areas were identified to be treated under this programme based on annual rainfall and the ratio of irrigated area to net sown area.
Drought vulnerability of irrigated agriculture is analysed by overlaying the determined agricultural drought severities of the area through the conventional demand supply gap and remote sensing based methods as well as the assessments by the criteria of Government of India for DPAP.

The drought severity classification was made based on the deficiency of irrigation supply in fulfilling the volume of water required for the crop in the particular crop season. The drought assessment of Rabi and kharif seasons was performed as per the proposed methodology. Drought classes were designated as 1, 2, 3 and 4 with drought severity as no, mild, moderate and severe categories respectively. The agricultural drought severity maps during the crop seasons are drawn.

The spatial distribution of drought risk was found out through neighbourhood analysis using GIS. The block boundary and drought risk distribution maps were overlaid to represent the spatial agricultural drought proneness over the blocks. Based on the above drought assessment, it can be concluded that the drought severity maps developed for different seasons based on the crop period would enhance the drought assessment from agricultural context. These maps would be useful for carrying out effective drought mitigation practices during the monsoon failure period. The proposed methodology estimates the water deficiency during the agricultural period, thereby quantifying the drought more accurately than before.

Agricultural drought assessment was carried out based on supply-demand estimation. The supply was taken as per the volume of water supplied in the field from pyderu and Alluru supply channel. The demand was estimated and the duty and volume of water required for the crop were estimated. The deference in the irrigation supply and demand was calculated in terms of percentage considering the demand as base variable. The
deficiency of irrigation supply in meeting the demand was estimated in terms of percentage for all the 14 Water Users Associations.

The remotely sensed dataset used in this study consists of Landsat data of Rabi and Kharif seasons. The area under agricultural vegetation has been derived from the images for each Water User Association (WUA) in ArcGIS. Using this, Drought Severity Index (DSI) was formulated and used to calculate the extent of agricultural drought severity for all the WUA’s. The DSI values are divided into four drought severity classes. Most of the WUA’s in the study area were falling under mild and moderate drought conditions.

As the various areas are included in DPAP based on rainfall values and the percentage area of irrigation, these data were collected for the existing blocks in DPAP are analysed. A vulnerability map for the study area in respect of each WUA is developed, which will be useful for the drought mitigation purposes.

The analysis of agricultural drought using remote sensing data indicates that a good correlation exists between rainfall and crop area. The developed methodology was applied to the sub basin of Pennar and the methodology can be adopted for any area. Drought severity maps developed using GIS will be very useful to study the spatial variation of drought occurrences across the study area. The information generated at WUA area level can be useful for prioritizing areas for droughts. As seen for the above analysis, some areas don’t meet the technical requirement norms of the criteria to be followed but included in the list. After these three decades of implementation of the DPAP, some areas are continuing to be in the DPAP list. These outcomes of this study should pave a way to set right the systems, if necessary.
7.3 CONCLUSIONS

Drought has been defined and analysed in many ways. There has been a lack of proper drought assessment procedure, which combines all the drought causing parameters. This study proposes an Integrated Drought Assessment procedure by incorporating various drought causing parameters. This presents a wholesome and complete description of practical field situation. The specific conclusions made out of this study are:

- Crop seasonal analysis shows that the study area gets about 1.5 times higher rainfall during Rabi season compared to Early Kharif season.

- WUA, having proximity to supply channel, are categorised as No drought to Mild drought. Further, the WUAs located in higher elevation with reference to the supply channel such as Dagadarthi are deprived of sufficient supply though they have proximity advantage to the nearness of supply channel and hence susceptible for mild to moderate drought proneness.

- All WUAs were less affected during the years 1998 and 2001 for Kharif season. The DVI shows that the WUA’s namely Dagadarthi & Peyyalapalem (head reach), Juvvaladinne (tail reach) falling under the moderate drought and Allurpeta and Gogulapalli (tail and middle reach) falling under mild drought category.

- During Rabi season, all WUAs were less affected in the following years 1993, 1996, 1999, 2004, 2006, 2007 and 2008. It is evident that, based on DVI ranges, the WUA’s namely Dagadarthi & Peyyalapalem (head reach) falling under mild
drought category and Gogulapalli and Juvvaladinne (middle and tail reach) falling under moderate drought category.

- High average irrigation area and moderate rainfall resulting only four mandals falls under DPAP for Kharif and one mandal for Rabi season within Nellore District. Therefore, the classification of Drought area under DPAP criteria within Nellore district was less significant.

- Since the DPAP doesn’t yield significant results, this is not included in the combined vulnerability assessment and mapping for an irrigated agriculture.

- The combined Drought Risk Index for Kharif season shows that the area under 2 WUA (Dagadarthi and Peyyalapalem) falls under Moderate Drought category and 4 WUA (Allurpeta, Gogulapalli, Juvvaladinne and Tulimela) comes under Mild Drought. Dagadarthi and Peyyalapalem were classified as moderate drought affected areas in conventional, remote sensing as well as in combined Drought Risk Index methods and hence these areas have maximum drought problem in comparison with the other areas during Kharif season.

- The study area receives more irrigation during Rabi compare Kharif season. Hence, the area under Juvvaladinne WUA alone falls under Moderate Drought category and 4 WUA (Dagadarthi, Peyyalapalem, Gogulapalli and Allimadugu) comes under Mild Drought.

- Juvvaladinne was classified as moderate drought affected areas in both conventional and remote sensing methods and hence the
area under this WUA has maximum drought problem in comparison with the other areas during Rabi season.

- The Dagadarthi, Peyyalapalem and Juvvaladinne areas always falls either in Mild or Moderate drought in both seasons in all the methods.

- Remote Sensing Technique can be effectively employed in assessing the water stress areas. An attempt has been made to use the LANDSAT satellite data, to generate agricultural drought severity maps by developing the NDVI statistics.

- Three WUA’s namely Singapeta-III, Juvvaladinne and Allimadugu were under moderate drought condition and remaining eleven WUA’s were under mild drought condition during Rabi season.

- 6 WUA’s namely Turimerla, Dagadarthi, Peyyala palem, Singapeta-III, Juvaladinne and Allimadugu were under moderate drought condition and remaining eight WUA’s were under mild drought condition during Kharif season.

- The results of DPAP analysis shows that very small area comes under criteria. Four mandals, namely Kondapuram, Anumasamudrampeta, Seetharamapuram and Jaladanki, falls within DPAP criteria during Kharif season and only Duttalur mandal during Rabi season.

- The combined Drought Risk Index for Kharif season shows that 2 WUAs (Dagadarthi and Peyyalapalem) falls under Moderate Drought category and 4 WUAs (Allurpeta, Gogulapalli,
Juvvaladinne and Tulimela) comes under Mild Drought. For Rabi season, Juvvaladinne WUA alone falls under Moderate Drought category and 4 WUAs (Dagadarthi, Peyyalapalem, Gogulapalli and Allimadugu) come under Mild Drought.

7.4 SPECIFIC CONTRIBUTIONS OF THIS STUDY

The following are the specific contributions of this study for drought research, assessment and management.

(i) Drought assessment procedure using conventional demand supply gap and Remote Sensing technique are demonstrated for the study area.

(ii) Insignificance of DPAP criteria in identifying drought prone areas even within any irrigated agriculture is brought out.

(iii) Drought vulnerability maps prepared for different crop seasons will help the planners for proper drought management / mitigation measures.