Review of state of environment in Keoladeo National Park, Bharatpur, Rajasthan and its catchment area: a historical analysis

Sponsored by

Socio-Economic Research Division, Planning Commission, Government of India

Conducted by

Environmental Impact Assessment Division
Sálim Ali Centre for Ornithology and Natural History
Coimbatore, Tamil Nadu

Study Team

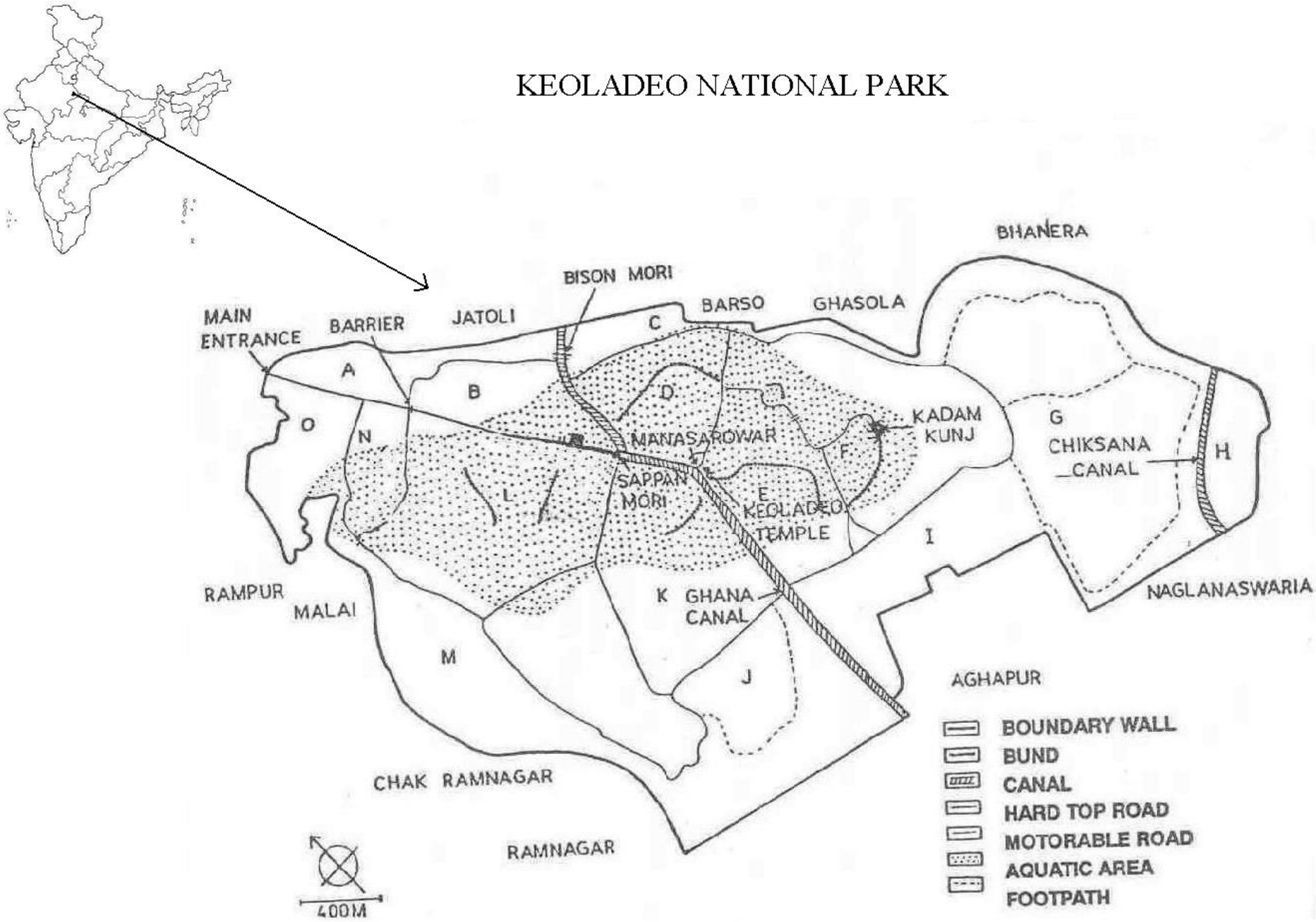
- Project Director:
  - Dr. B. Anjan Kumar Prusty
- Research Personnel:
  - Mr. Mohd. Zeeshan
  - Ms. Natasha Shrivastava

Environmental Impact Assessment Division

Sálim Ali Centre for Ornithology and Natural History

Coimbatore - 641108, Tamil Nadu

KEOLADEO NATIONAL PARK



Ecosystem Monitoring of Keoladeo National Park

1927-1953	Sálim Ali (Natural History of KNP and its surroundings)
1981-1990	Ecosystem Monitoring of Keoladeo National Park – 1st Phase
1994-1996	Status Assessment of Python population in KNP
1996-2001	Ecological Study on Siberian Crane in KNP
1997-2004	Economic Valuation of Biodiversity in KNP
2002-2006	Ecosystem Monitoring of Keoladeo National Park – 2nd Phase
2006-2007	Heavy metal speciation and mobility in soil system in KNP
2007-2012	Strengthening community parternership for conservation of KNP
2011-2012	Historical Analysis of KNP and its catchment areas

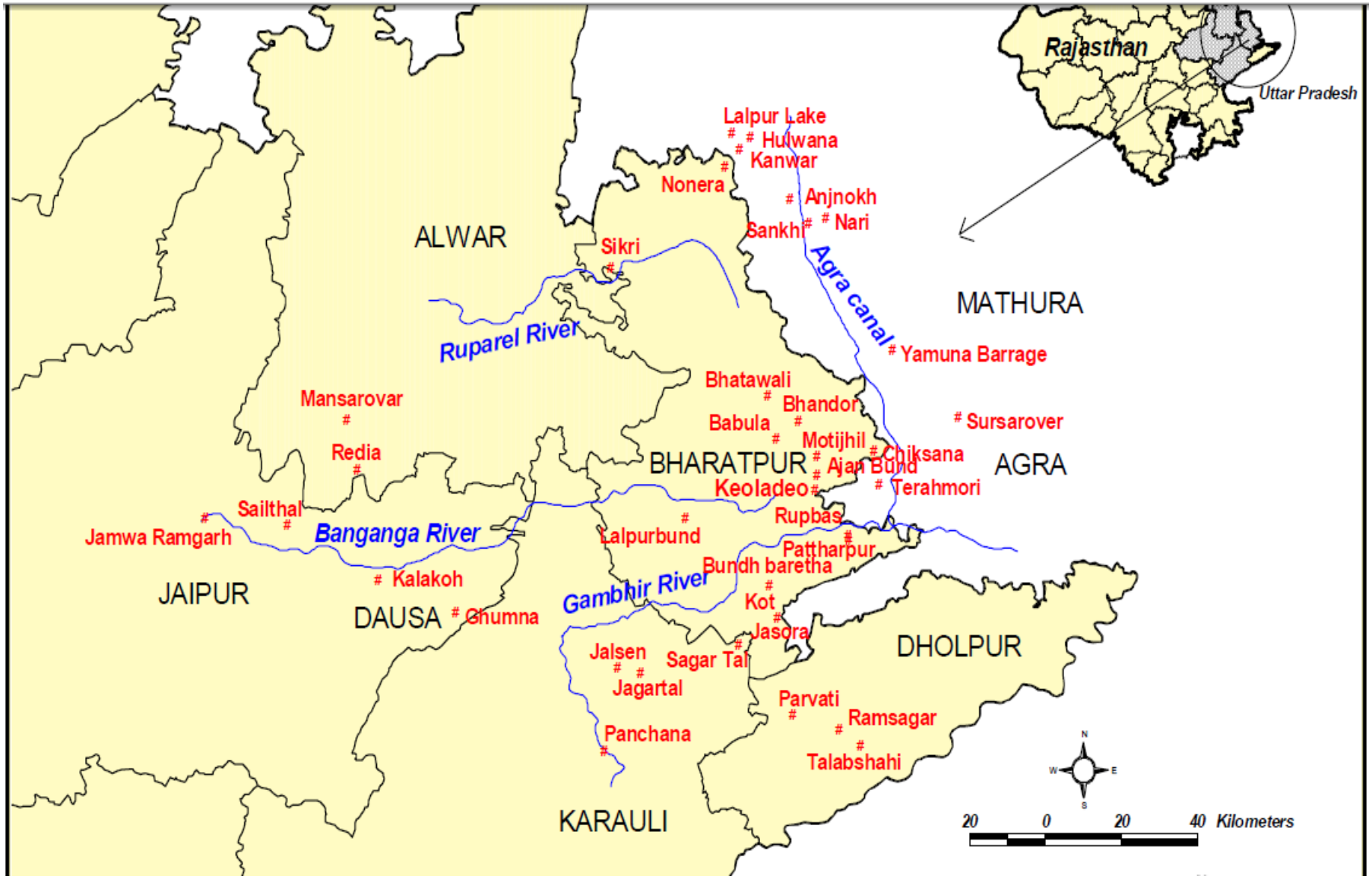
Publications: 400+…. and still on….

Still a comprehensive compilation of all the reported studies was never attempted…

Current scenario

- Increased frequency of droughts
- Prolonged water scarcity
- Micro watersheds (desertification control etc.)
- Restricted flow of water in the catchment
- Differential inflow of agrochemicals to wetlands in the catchment
- Consequential differential exposure of contaminants to different trophic levels

High value biodiversity areas (HVBA)



Courtesy: Wildlife Institute of India & Rajasthan Forest Department

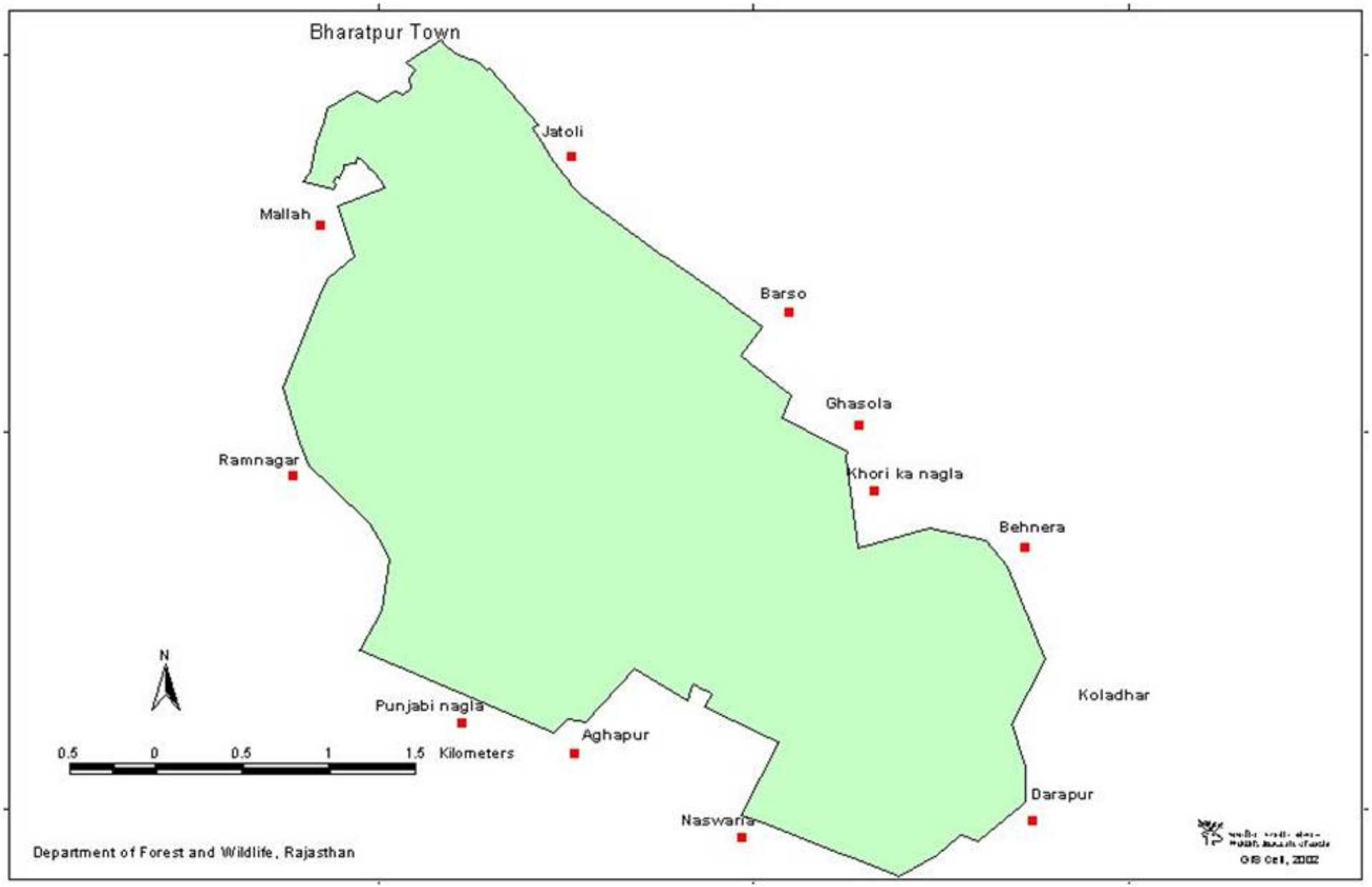
Objectives

The present study was attempted to accomplish the following objectives:

- review of state of environment in KNP and its catchment area, and
- historical analysis of the information in view of the changing climate over time and anthropogenic pressures.

Location of KNP near Bharatpur city, India

Villages around KNP, Bharatpur, Rajasthan, India



Methodology

- The major aim of the present exercise was to make a situation analysis and review of the scientific studies undertaken in and around the KNP, explore the research gaps, and plan futuristic strategy. This included
  - reviewing the present scenario in and around the KNP,
  - revisiting the completed scientific investigation on KNP and its catchment,
  - collecting and collating the findings of published and unpublished documents, and
  - analyzing the data for examining decadal changes in several ecological variables

Approach

- Macro level approach
  - Preliminary desk review; collection and collation of secondary information from various sources
- Micro level approach
  - Generation of primary data using standard field methods and other tools such as questionnaire survey, and discussion with stakeholders

Macro level approach

- Details of the research works undertaken in and around KNP were collected from The Director, Keoladeo National Park, Bharatpur.
- Efforts were made to collect the available information from the following sources:
  - Newspaper reports/articles
  - Research articles published in scientific journals
  - Research reports and dissertations from academic and research institutions
  - Information available online
- Records from various line departments of Government of Rajasthan, Government of India and other relevant sources such as Department of Forest and Wildlife, Agriculture, Irrigation, Rural Development, State Pollution Control Board, Directorate of Economics and Statistics, State Ground Water Board, and Regional Census Office – Jaipur, India Meteorology Department (IMD), Jaipur.
- The collected information were collated and sorted out into a temporal scale of 10 years and/or as appropriate based on the availability of datasets to analyze the annual/decadal changes

Micro level approach

- To gain basic understanding about the perception and opinion about ground scenario and the changes occurring over time, discussions were held with stakeholders. Following approaches were adopted:
  - Customized questionnaire survey (household level), and
  - Interaction with naturalists and armature bird watchers

Matrix of collected information (time and duration)

Sr. No.	Aspects	Year/ Duration
1	Human population	1951 to 2011
2	Livestock population	1966 to 2007
4	Industrial growth	1978 to 1993
5	Agricultural area	1956-57 to 2010-2011
6	Ground water availability and quality	2002 to 2010
7	Land use land cover changes	1973-2010
9	Wetland in the particular district	Since last 40-50 years
10	Imageries for land changes analysis	Last 40 years
11	Meteorological data	Since 1961 – 2012 and 2004-2011
12	Fertilizer Usage Data	1991-1992, 1994 -1997, 1999-2001, 2007-2008, 2009-2010
13	Questionnaire survey	Discussion with villagers
14	Articles published in various research journals	-----

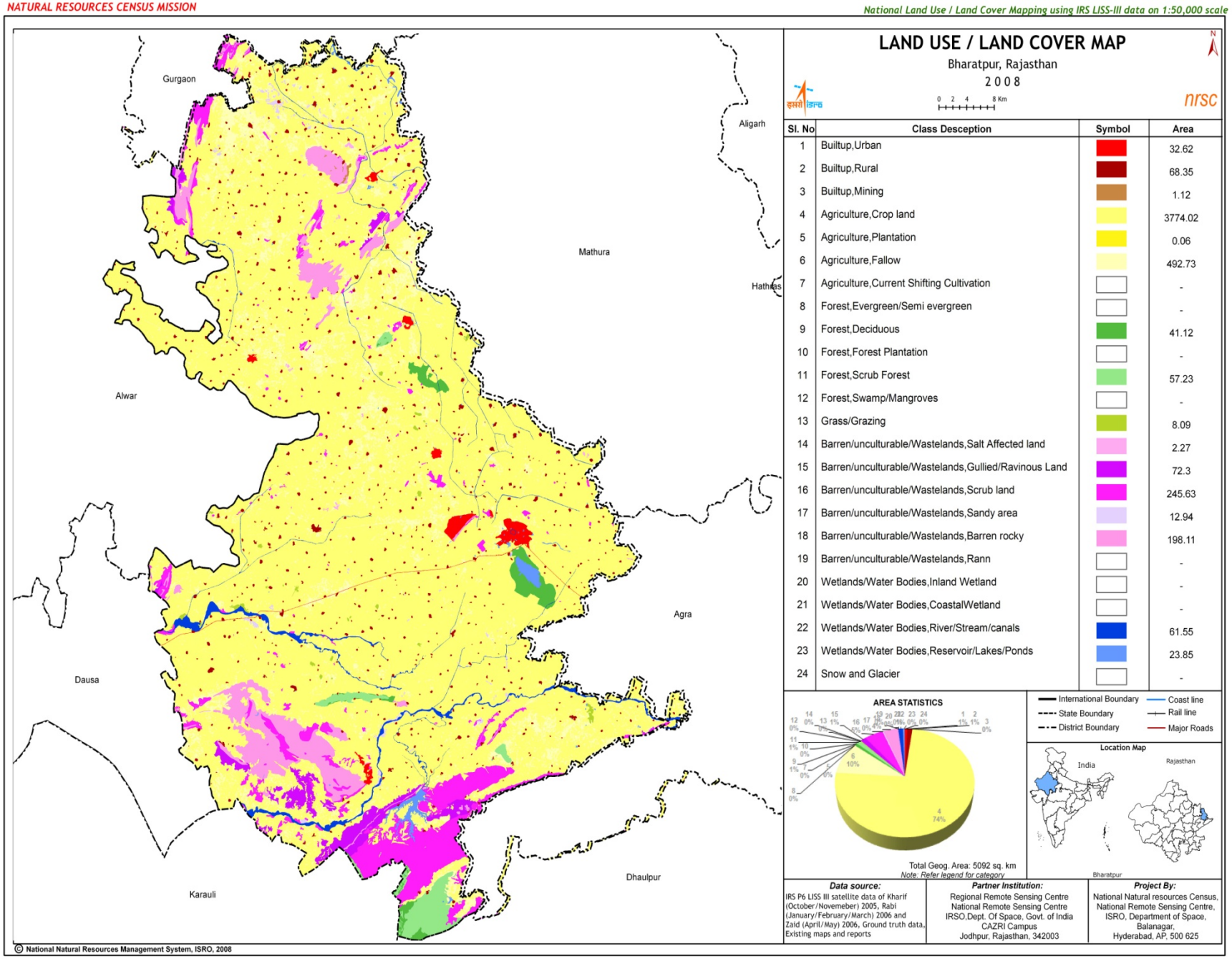
Data Analyses and Syntheses

- Collected information was collated and segregated into temporal scale of 10 years or the nearest possible duration
- Scientific literatures describing different ecological components of KNP and Bharatpur were reviewed and data describing the lists of the species were extracted and complied.
- Each research report/article was considered as a sampling unit for the purpose of statistical analysis.
- Species accumulation curve was plotted and modelled using best fit logarithmic (regression) model.
- EstimateS software (version Win820) was employed to the dataset to understand about other suitable estimators, i.e. Chao 1, Jackknife 1 and Bootstrap to ascertain the actual number of species that might be recorded from the KNP and Bharatpur region upon continuance of scientific studies.

Data Analyses and Syntheses Cont…

- In addition, threat status of each of the taxa, under analysis, was compiled as per IUCN red list categories.
- Data collected from different departments on various environmental parameters were subjected to several statistical tests using the software MEGASTAT 8.8 (Orris 2000).
- To find the range, mean and distribution different variables under the present investigation, basic descriptive statistics was performed.
- Linear regression models were established for appropriate variables.

Land use land cover map of Bharatpur

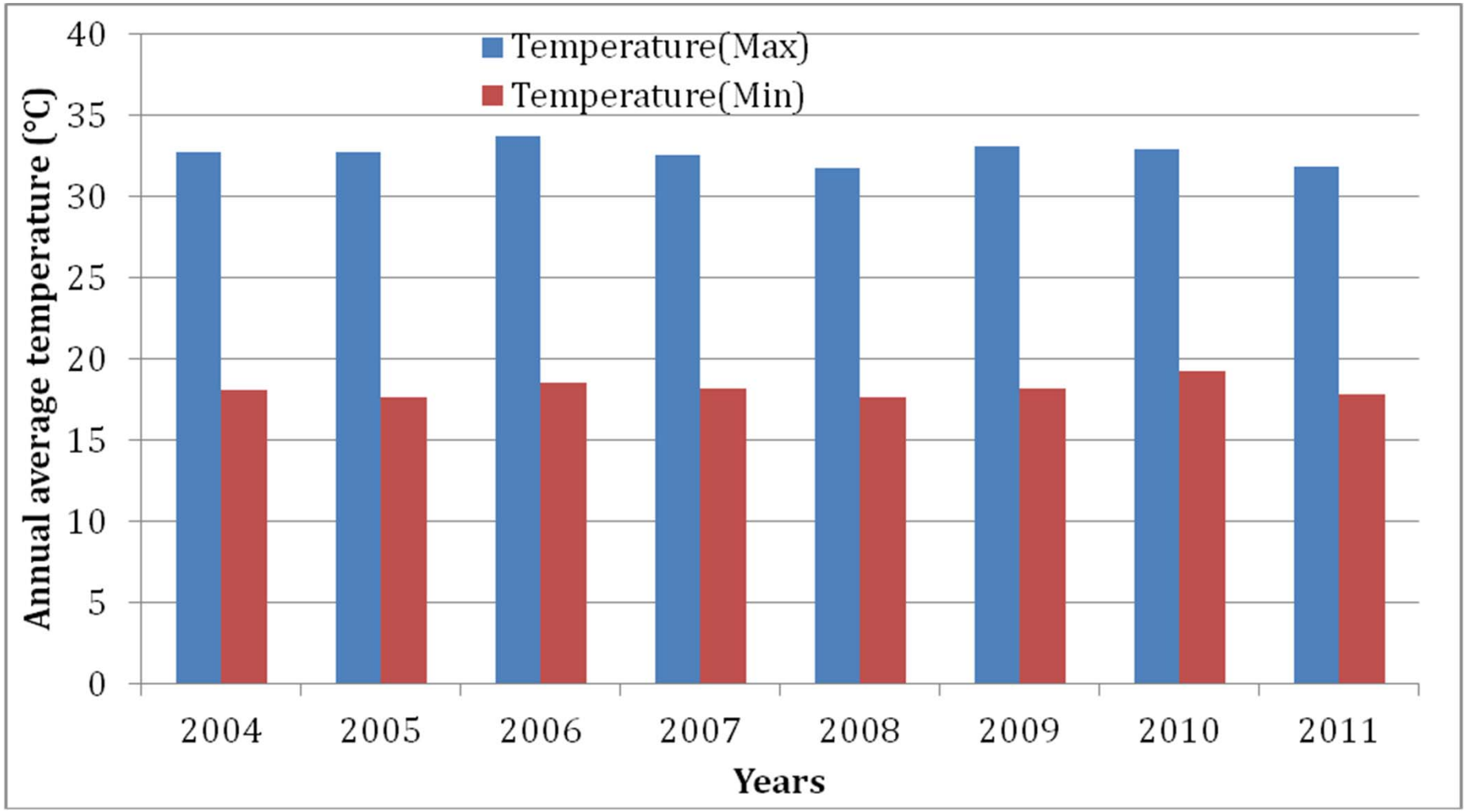


Area statistics of different land use categories in Bharatpur

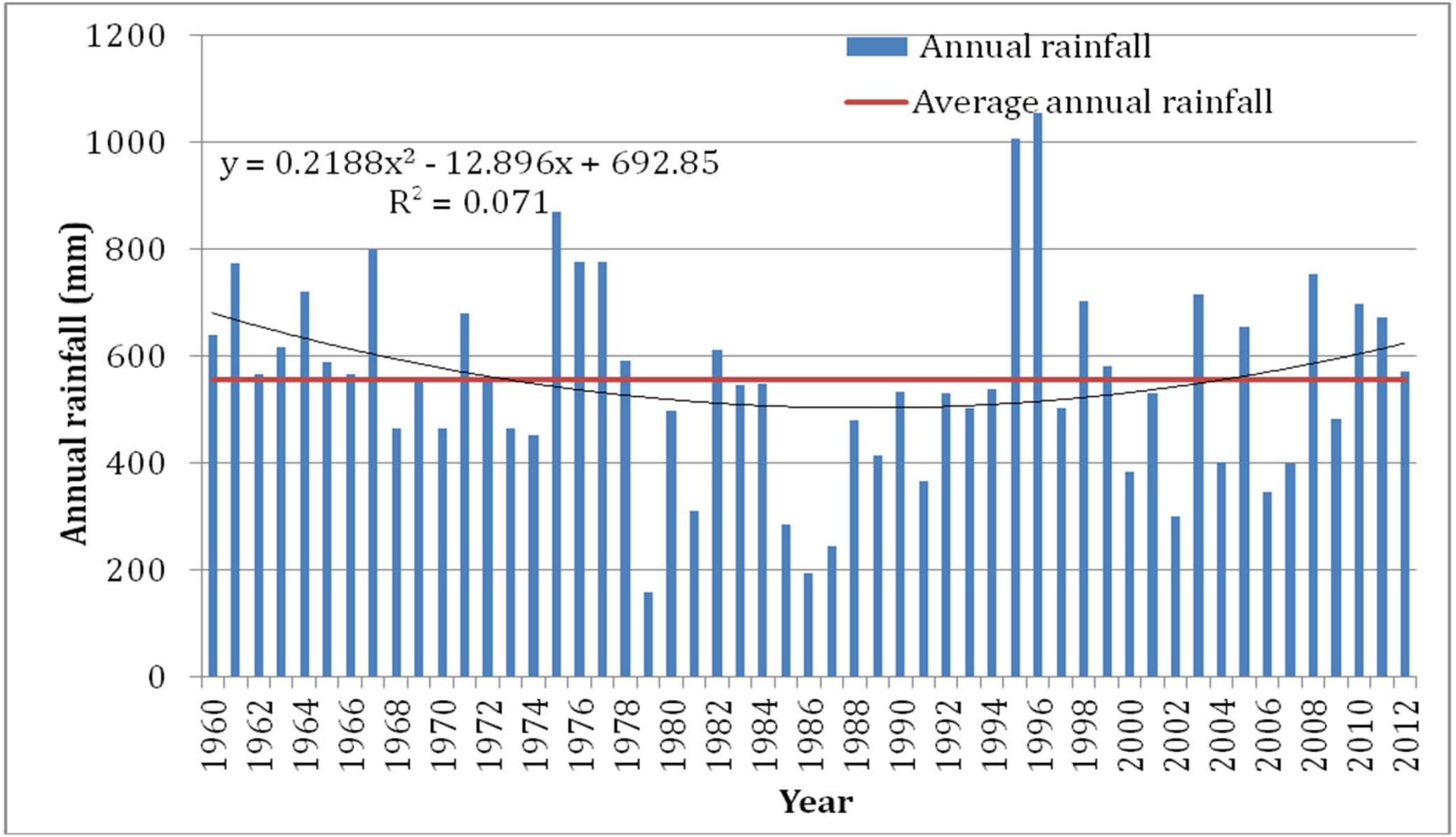
Sl. No	Land use Landover class	Area (km^2)
1	Agriculture, Crop land	3774.02
2	Agriculture, Fallow	492.73
3	Agriculture,	0.06
4	Barren / Unculturable / Wastelands, Barren rocky	198.11
5	Barren/ Unculturable / Wastelands, Salt Affected land	2.27
6	Barren/ Unculturable / Wastelands, Scrub land	245.63
7	Barren/ Unculturable / Wastelands, Gullied/ Ravenous land.	72.3
8	Barren/ Unculturable / Wastelands, Sandy area	12.94
9	Built-up, Mining	1.12
10	Built-up, Rural	68.35
11	Built-up, Urban	32.62
12	, Deciduous	41.12
13	Forest,	57.23
14	Grass/Grazing	8.09
15	Wetlands / Water Bodies, Reservoir / Lakes / Ponds	23.85
16	Wetlands/Water Bodies/River/Stream/Canals	61.55
Total		**5091.99**

Source: NRSC, ISRO,

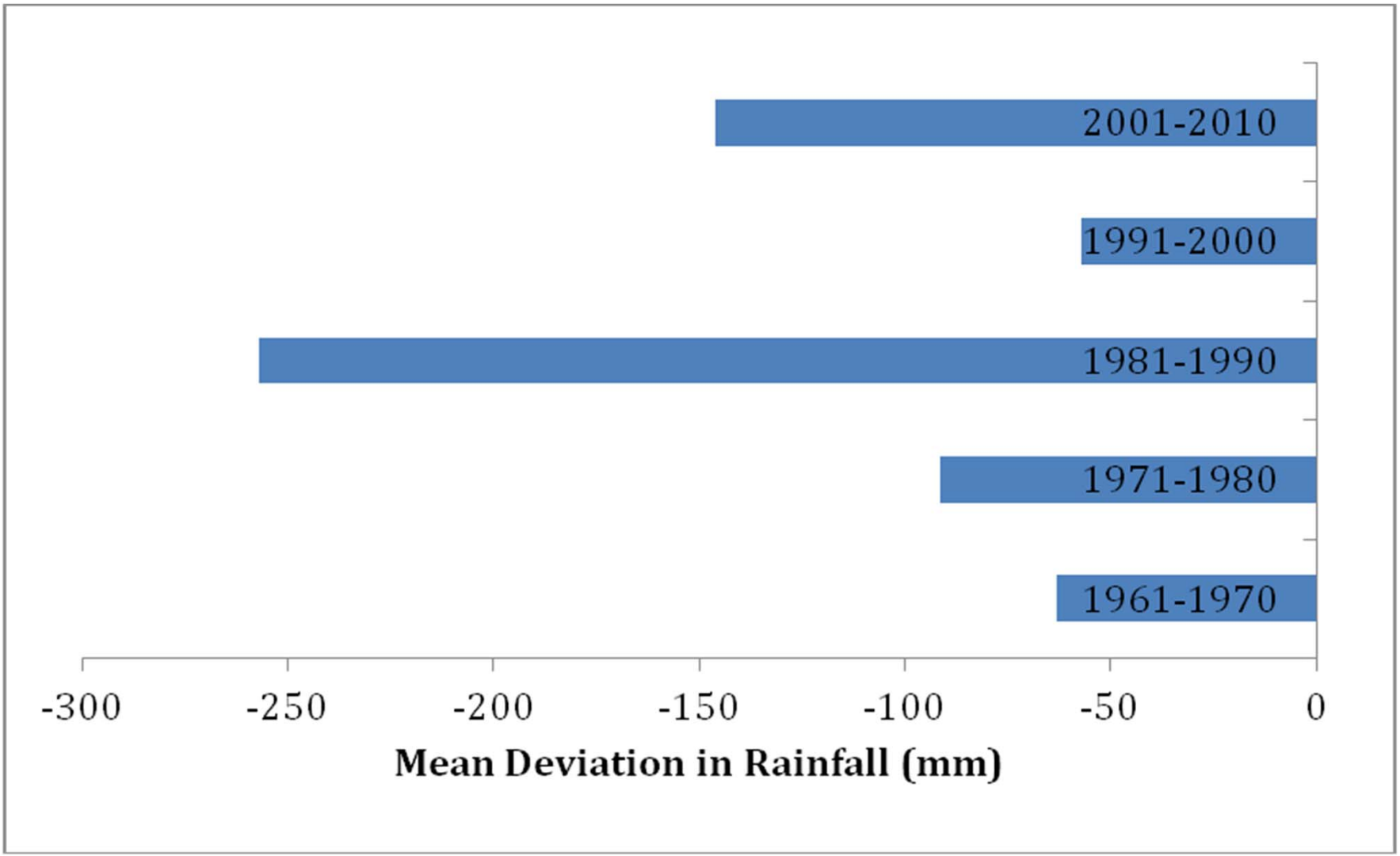
Trends in annual average temperature in Bharatpur



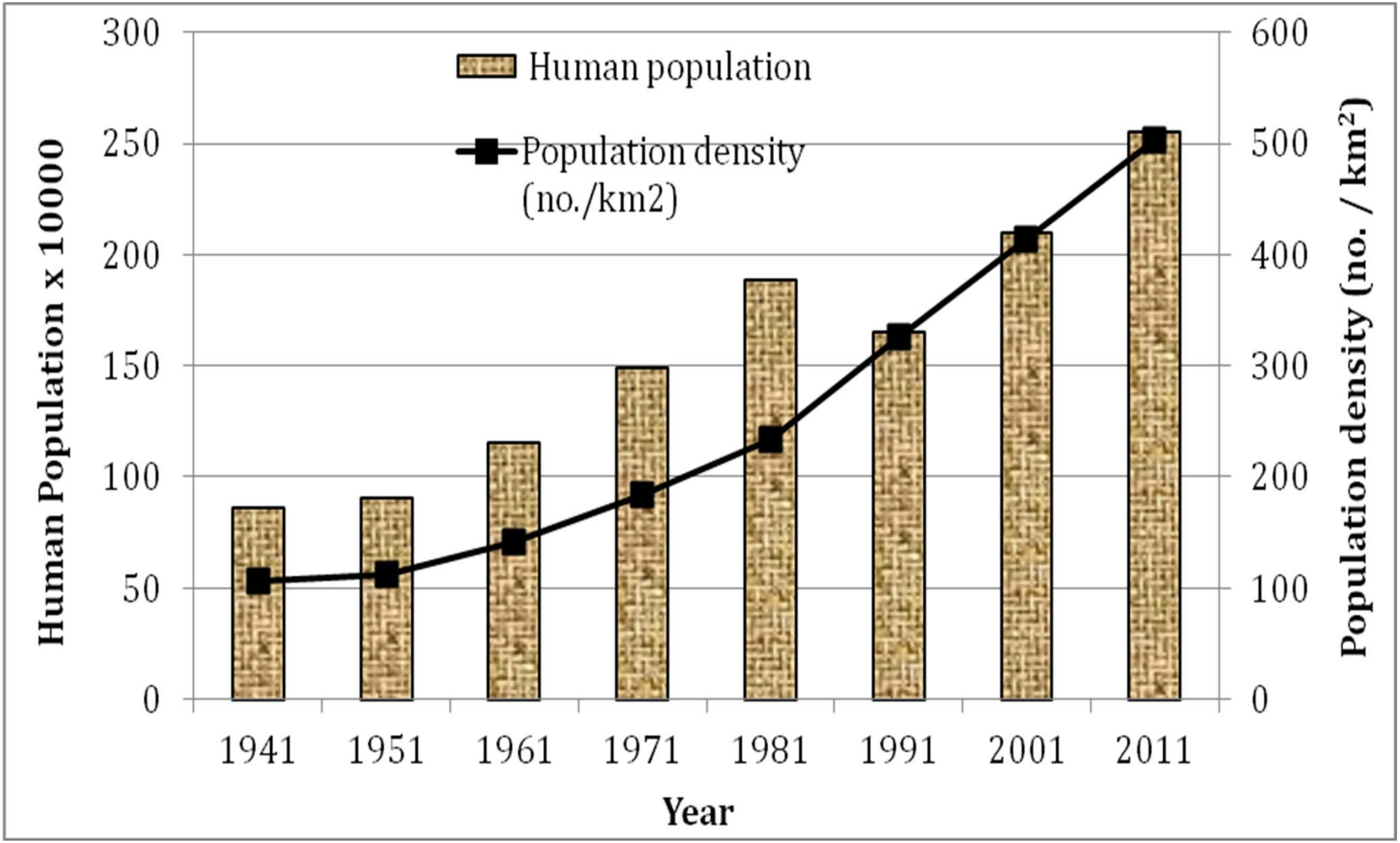
Trends in annual rainfall in Bharatpur from 1960 - 2012



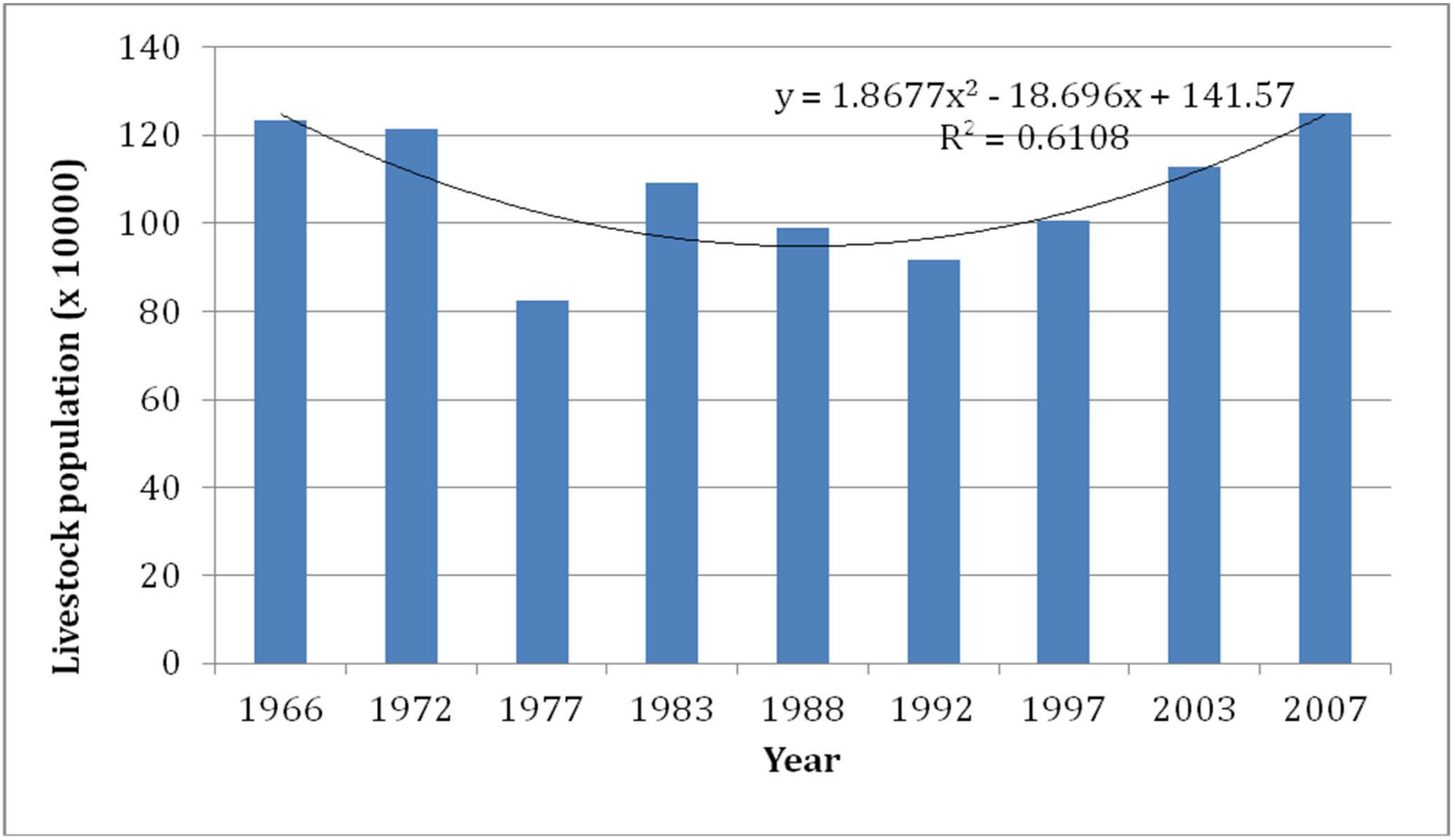
Deviation (from normal) in annual rainfall during 1961 - 2010



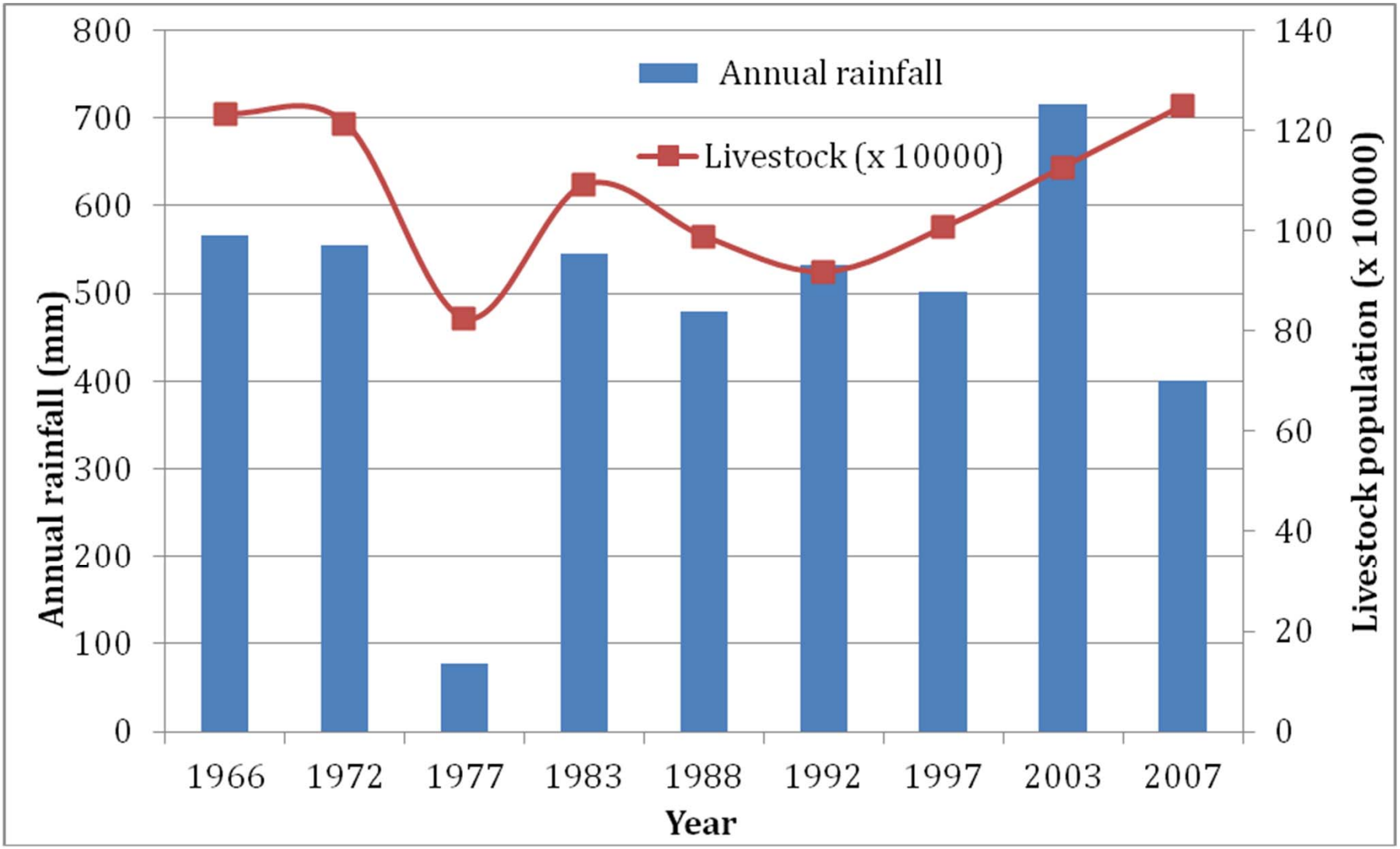
Demography of Bharatpur from 1941 - 2011



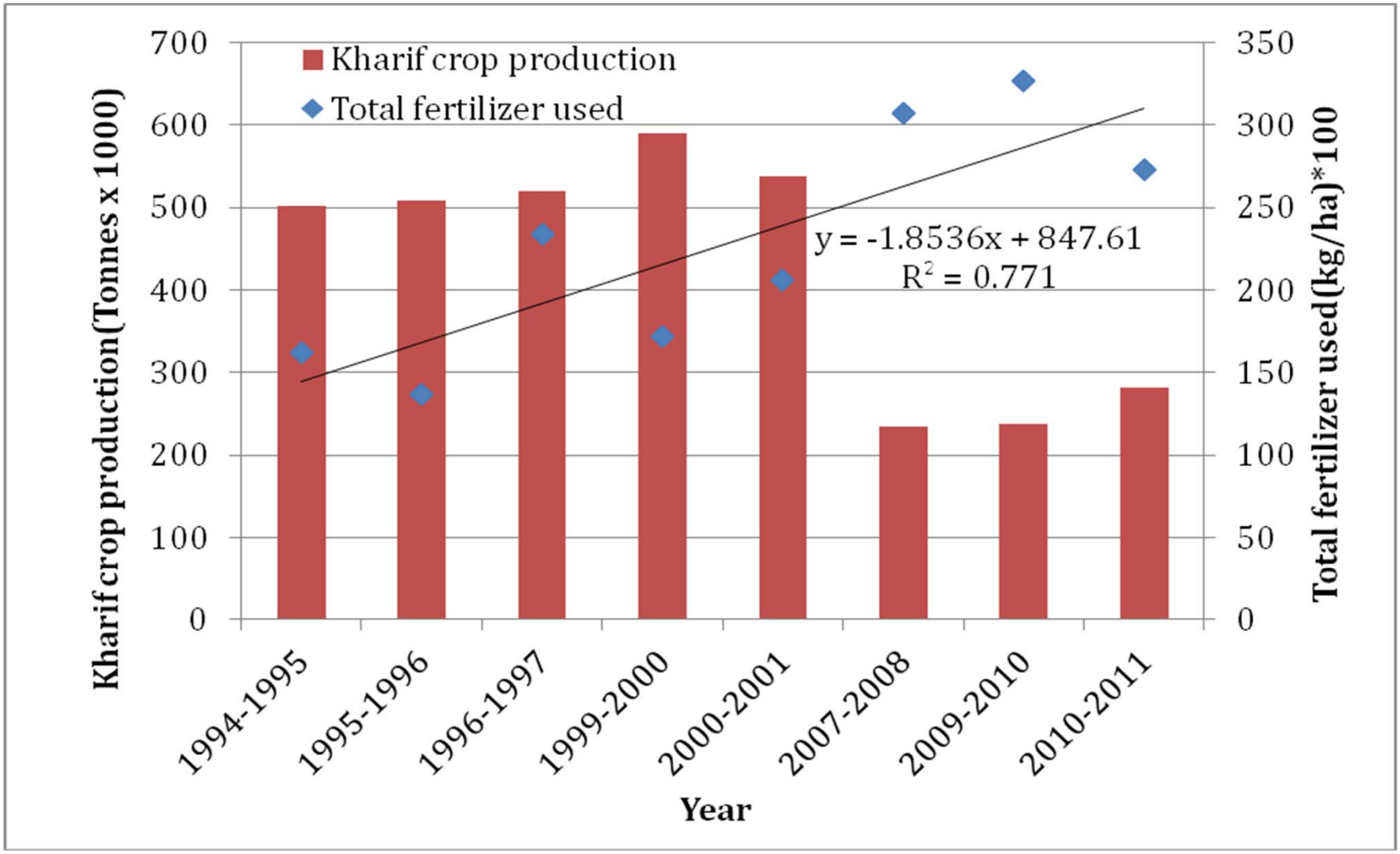
Livestock population for Bharatpur from 1966 - 2007



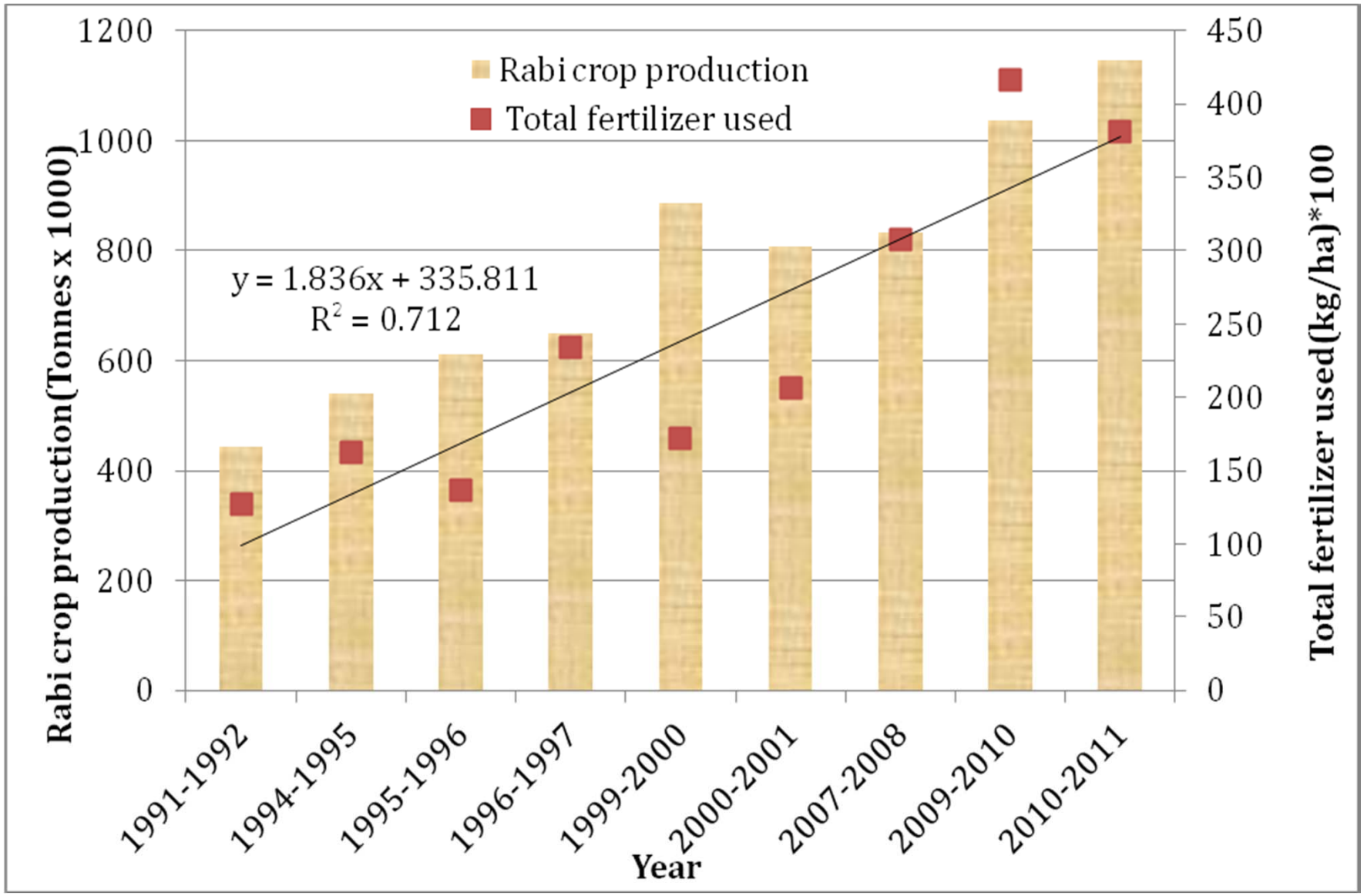
Annual rainfall and livestock population in Bharatpur



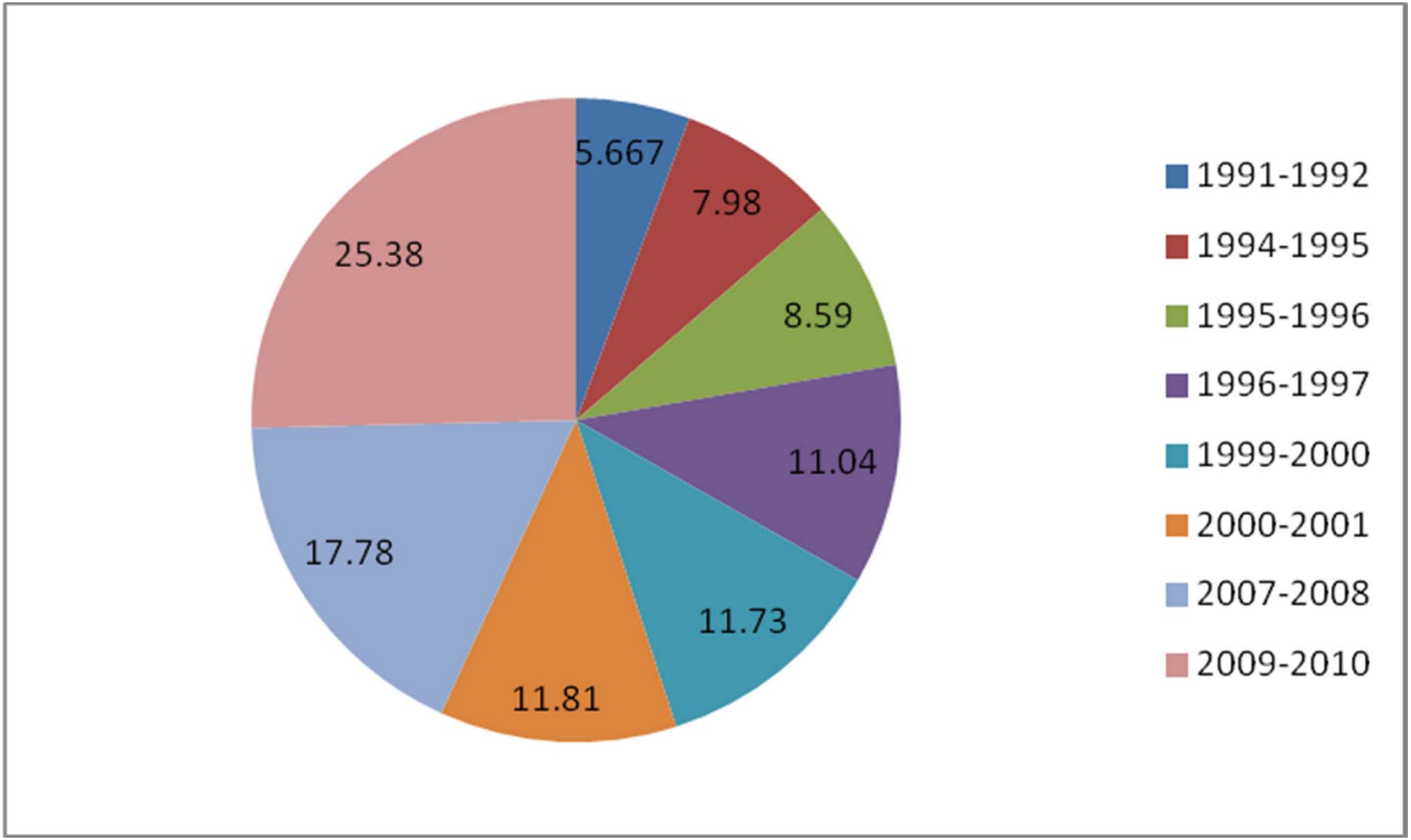
Kharif crop production and fertilizer application



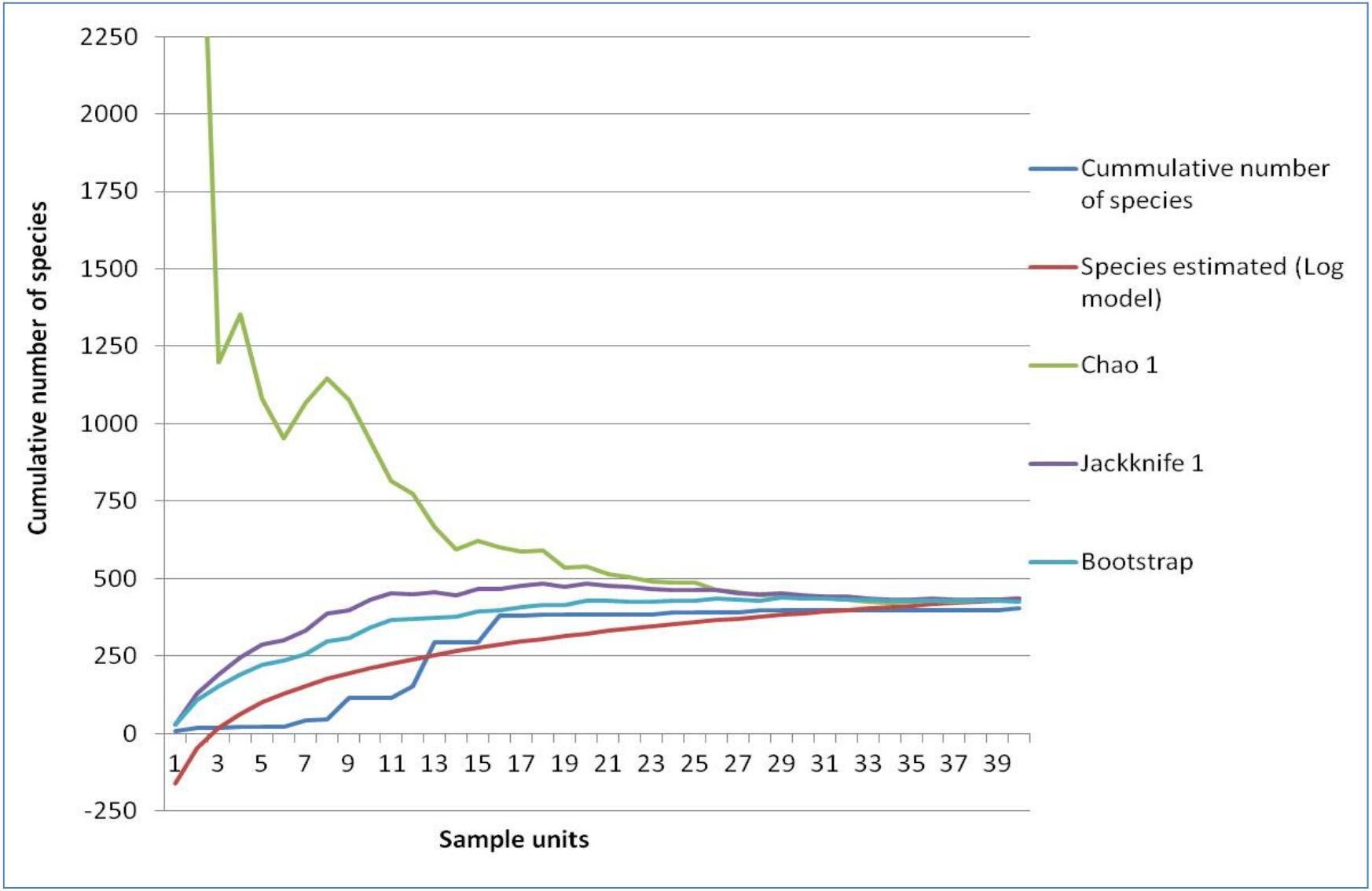
Rabi crop production and fertilizer application



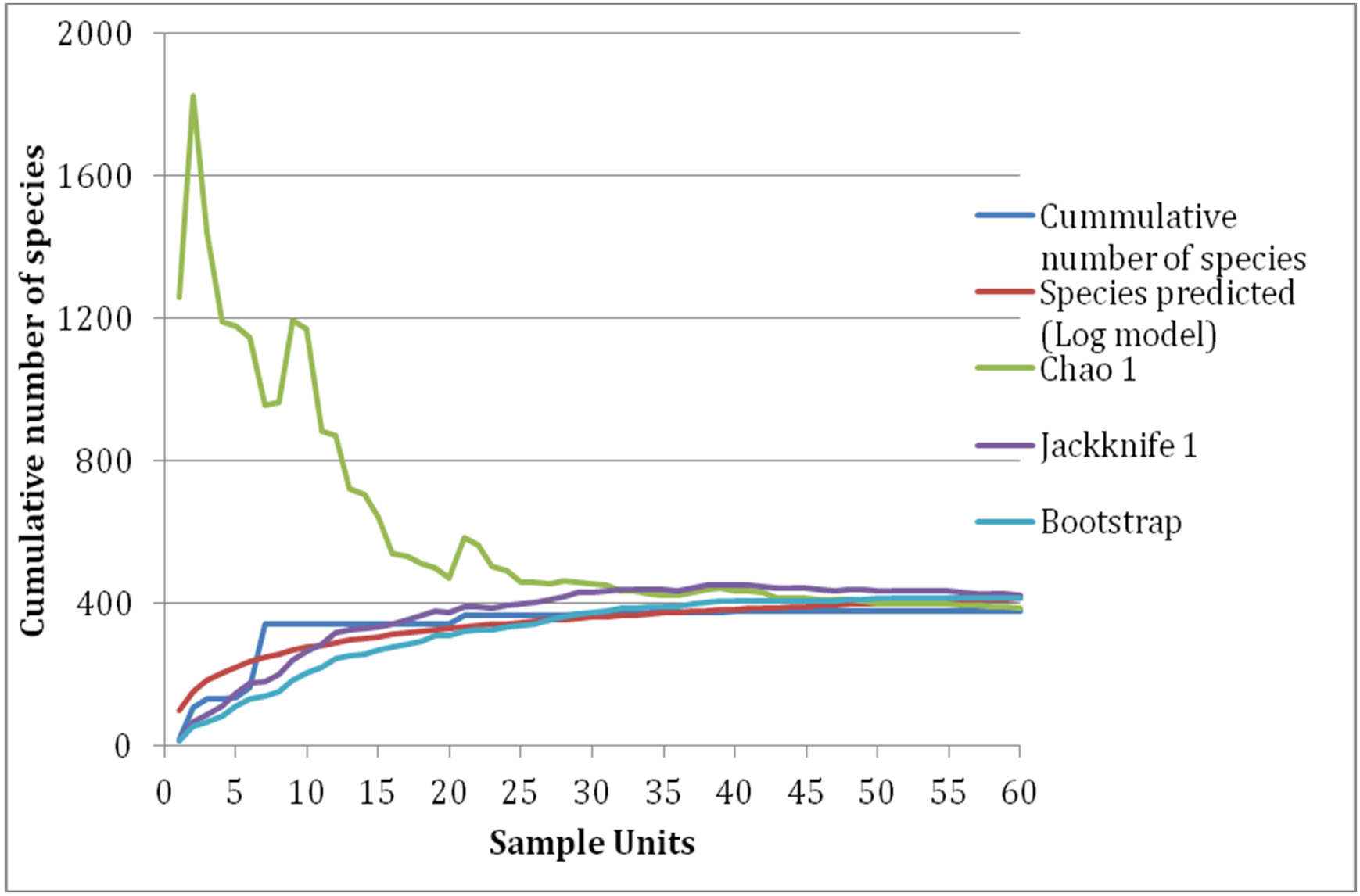
Proportion of fertilizer use in Bharatpur across the years



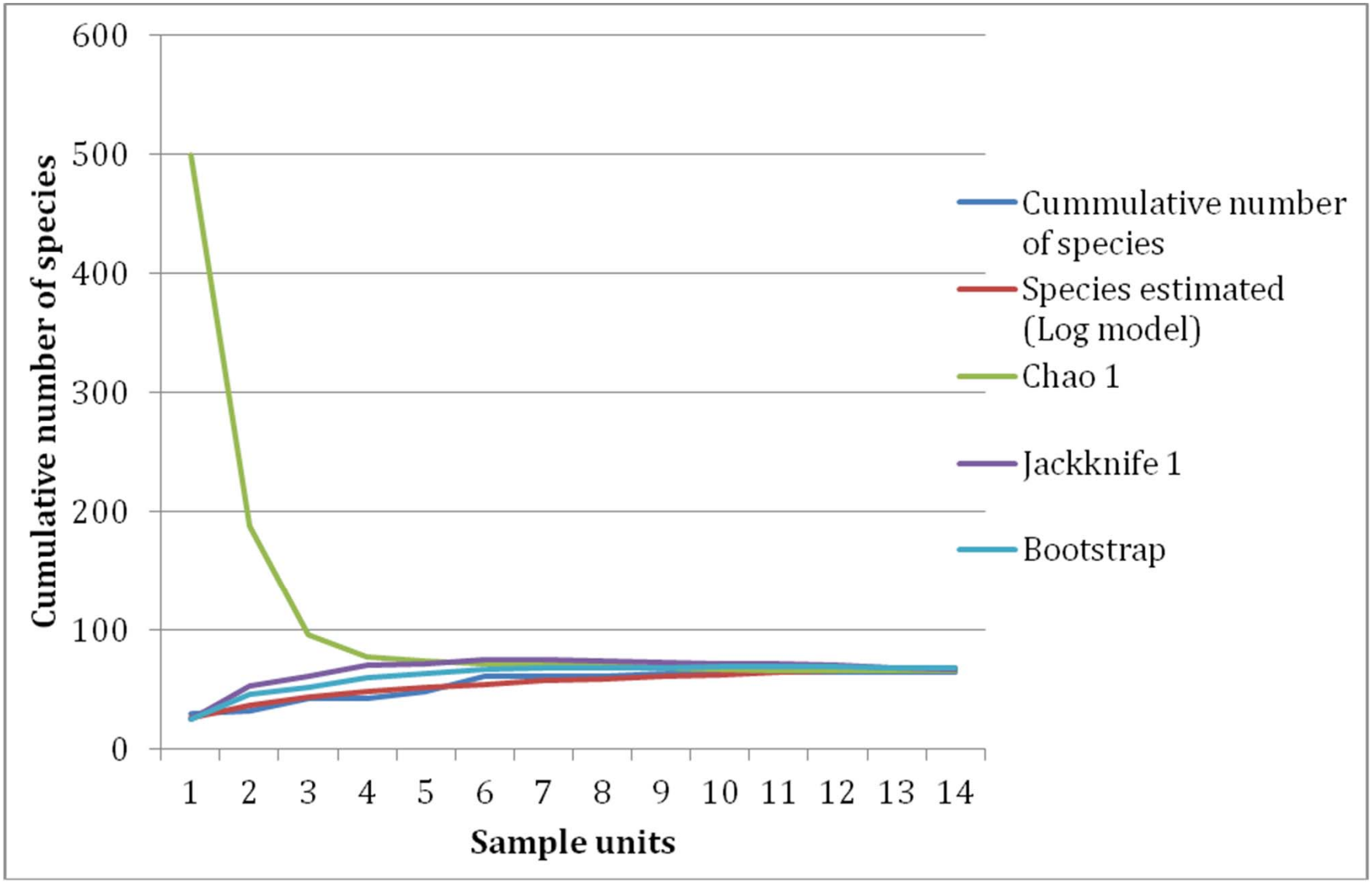
Species accumulation curves for vegetation in KNP



Species accumulation curves for avifauna in KNP



Species accumulation curves for ichthyofauna in KNP



List of organisms recorded during macrophytes decomposition

Sl. No.	Organisms	Sl. No.	Organisms
1	Anacystis	14	Mosquito Larva
2	Caenis	15	Odonata
3	Calanoid	16	Oligochaeta
4	Chironomus	17	Ostracod
5	Cladocera	18	Pediastrum
6	Cladophora	19	Planorbis
7	Closterium	20	Polycentropidae
8	Copepod	21	Psycodid
9	Ephimeroptera	22	Rotifer
10	Gyrinid	23	Tipulid
11	Hygrobatidae	24	Watermite
12	Leech	25	Wolfia
13	Limnea	---	----

Source: Azeez et al. (2007)

Households and population in villages

Name of Village	Area (ha)	Population	No of House holds	Male	Female	Scheduled Caste		Scheduled Tribe	
						Male	Female	Male	Female
Aghapur	631	1648	227	894	754	21	17	0	0
Bahnera	473	2595	410	1395	1200	393	338	0	0
Barso	248	1985	263	1055	930	77	50	0	0
Chak Bahnera	82	101	18	57	44	0	0	0	0
Chak Naswaria	59	198	29	109	89	0	0	0	0
Chak Ramnagar	79	434	69	230	204	0	0	0	0
Darapur kalian	312	806	43	416	390	4	3	0	0
Darapur khurd	232	842	117	439	403	125	118	0	0
Ghasola	404	1952	252	1048	904	487	415	0	0
Jatoli	246	1433	192	790	643	162	141	4	4
Mallah	659	5183	762	2826	2357	1079	897	0	0
Ramnagar	193	857	119	431	426	138	146	0	0
Nagla	124	102	17	53	49	0	0	0	0
Naswaria	166	101	694	387	307	24	21	106	88
Harnagar	114	1374	187	747	627	285	232	0	0
Source: Census of India									

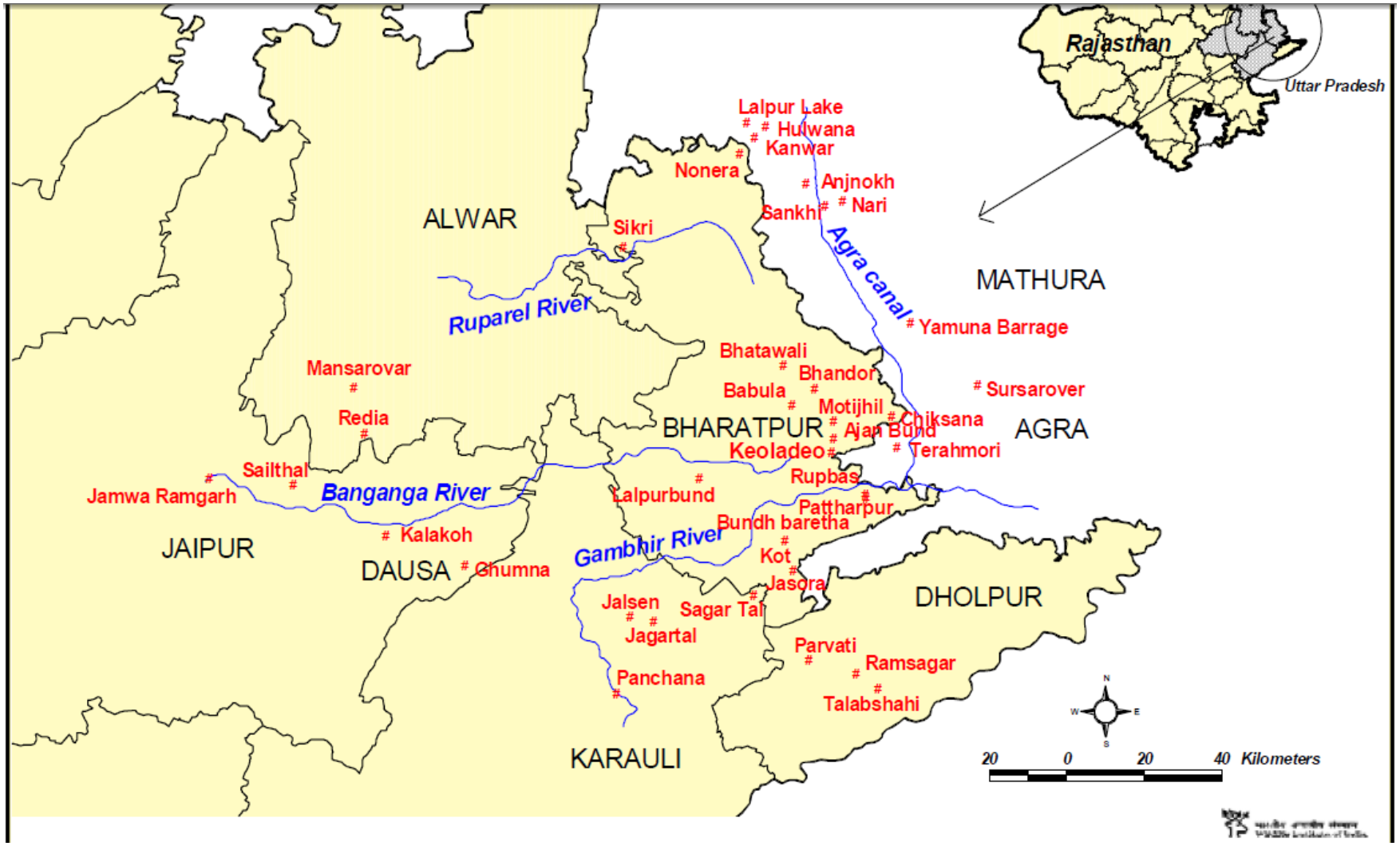
Source of income (%) in each village

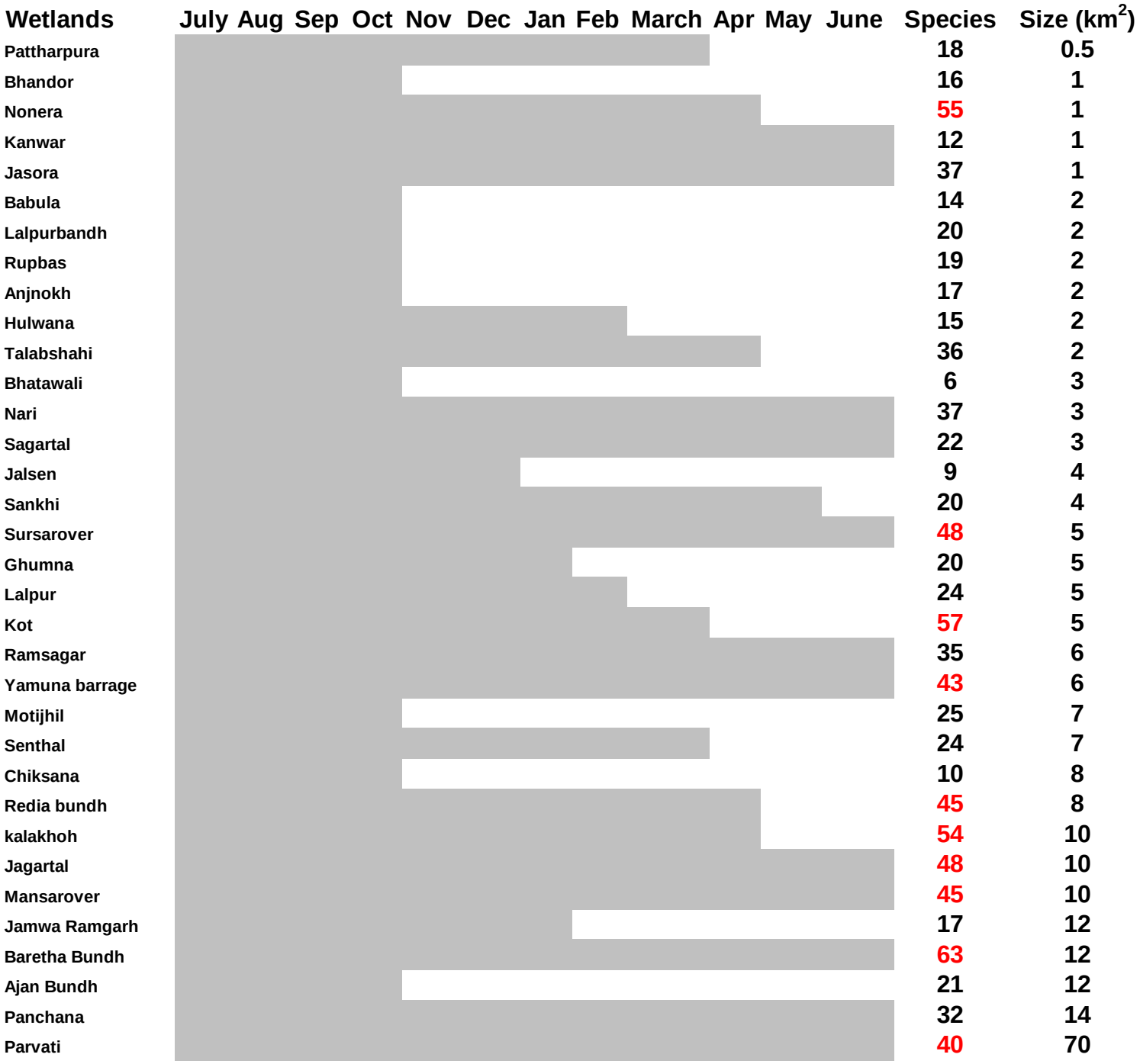
Village	Salary/wages	Agriculture	Livestock
Aghapur	33.33	57.14	9.53
Bahnera	30.00	60.00	10.00
Banjara Nagla	75.00	25.00	0.00
Barahpura	36.36	45.45	18.19
Barkhera	62.00	30.00	8.00
Barso	50.00	50.00	0.00
Chak Ji Barpur	46.00	49.00	5.00
Chakramnagar	83.33	0.00	16.67
Darapur	30.76	53.84	15.40
Ghasola	50.00	50.00	0.00
Harnagar	72.00	22.00	6.00
Jatoli	46.15	46.15	7.70
Langara	75.00	15.00	10.00
Malah	43.47	30.43	26.10
Medi	20.00	72.00	8.00
Naswaria	50.00	0.00	50.00
Pathaar	70.00	20.00	10.00
Philwara Papat	15.00	85.00	0.00
Rami	45.00	55.00	0.00
Ramnagar	14.30	85.70	0.00

Source of fuel (%) in each village

Village	Wood	Dung cakes	Gas
Aghapur	35.29	47.07	17.64
Bahnera	25.18	45.45	29.37
Banjara nagla	50.00	50.00	0.00
Barahpura	50.00	10.00	40.00
Barkhera	50.00	30.00	20.00
Barso	48.00	33.00	19.00
Chak Ji Barpur	40.00	40.00	20.00
Chakramnagar	66.66	16.68	16.66
Darapur	33.33	50.01	16.66
Ghasola	50.00	40.00	10.00
Harnagar	67.00	27.00	6.00
Jatoli	38.46	46.16	15.38
Langara	75.00	23.00	2.00
Malah	36.36	40.92	22.72
Medi	40.00	50.00	10.00
Naswaria	50.00	50.00	0.00
Pathaar	70.00	25.00	5.00
Philwara Papat	50.00	50.00	0.00
Rami	54.00	38.00	8.00
Ramnagar	71.42	28.58	0.00

Satellite Wetlands around KNP, Bharatpur





Satellite wetlands and their hydrological details *(located within 200 km from KNP in order of their increasing distance from KNP)*

Recommendations

- Present compilation
  - A bibliography with 418 reports (both published and unpublished), research articles, conference proceedings, dissertations and theses, and books and booklets
  - Helped in identifying research gaps and priority areas that need to be studied to help maintaining the ecological integrity of KNP, its surrounding ecosystems, and catchment areas
  - Research matrix was prepared, and accordingly, the research areas are divided in two major heads:
    - those required to be undertaken for the first time and
    - those that require a revisit and comparison with earlier reported findings.

Recommendations Contd.

1. Research gaps: initial assessments
   i. Seed-bank for KNP: Investigate the carrying capacity and minimum ecological requirement of seeds of both plants and fishes of the Park,
   ii. Assessment of health of satellite wetlands around KNP and their suitability as alternate habitats for both resident and migratory bird,
   iii. Flow regime and Environmental flow: Examine the flow regime of rivers supplying water to KNP, and assess the environmental flow as an aid in decision-making process,
   iv. Nutrient and contaminant budgeting in the upstream areas of KNP especially in the catchment areas of the rivers need to be examined. It is expected that sub-surface flow must be inducing the spatial movement of agro-chemical residues in the region,
   v. Assessment of quality of inflow water from alternate sources such as Chambal river and Govardhan drain,

Recommendations Contd.

1. Research gaps: initial assessments

vi. Investigate the co-existence and resources partitioning of major herbivores such as nilgai, sambar, chital, and feral cattle that would provide information which could help the management of habitat and population of these species in KNP in the present context,

vii. Examine the changes in vegetation pattern and soil quality due to ongoing invasive species eradication programme. Investigate the role of KNP in carbon sequestration,

viii. Cumulative Impact Assessment on land use changes, intensification of agriculture, hydrology and water regime, infrastructure development, ground water extraction, increase in visitors, etc.,

ix. Identification of indicator species and its ecology needs to be studied for the long term conservation of the Park,

x. Assessment of Ecosystem services of KNP and its economic evaluation, and

xi. Creation of research database and analysis on research-management interface.

Recommendations Contd.

2. Research gaps: revisit and comparison

i. Study the land use changes around the Park focusing on both urbanization and agriculture,

ii. Revisit the vegetation cover of KNP and prepare a revised vegetation map for the Park,

iii. Review the scenario on agriculture: intensification of agriculture, and use of organic fertilizers,

iv. Assessment of levels of agrochemical residues in various environmental compartments across trophic levels,

v. Regular monitoring of water quality and pollutants levels inside the Park is to be carried out to monitor the health of aquatic ecosystem,

vi. Assessment of ground water quality and impact of agrochemical inputs on aquifers and around Bharatpur,

Recommendations Contd.

2. Research gaps: revisit and comparison

vii. Comprehensive Environmental Assessment and Monitoring for the KNP ecosystem and the adjoining areas with respect to biophysical and socio-economic aspects. This would help the PA Management to take corrective measures,

viii. Periodic monitoring of status of Sarus Crane, Vulture and Python population and their habitats for their long term conservation inside the Park,

ix. Bird migration study: Since thousands of migratory birds visit KNP, it provides ample opportunity for bird ringing and monitoring. Through such attempt it would be easy to examine spatial movement of contaminants through organisms such as birds,

x. Climate change and avian influenza: Study the impact of global climate change, avian influenza etc. on global bird communities and their migration to and from KNP. This also provides an opportunity to study the epidemiology of avian influenza in India,

Recommendations Contd.

2. Research gaps: revisit and comparison

xi. Aquatic-terrestrial habitat relationship: Due to changing climate and land use pattern the habitat relationship between aquatic and terrestrial ecosystems of the Park needs to be studied,

xii. Growth of invasive species: Study the impact of wild and feral mammalian herbivores on the management of invasive species in the Park (seed dispersal),

xiii. Evaluation of the catchment area to understand the land use pattern and its impact on the Park environment,

xiv. Tourism and its impact: Assessment and inventorization of tourism resources for diffusing increasing tourism pressure from KNP. The impact of tourism on KNP and its habitat needs to evaluated, and the completed studied need to be revisited, and

xv. Socio-economic assessments and economic evaluation need to be undertaken for the surrounding areas of KNP.

Acknowledgements

- SER Division, Planning Commission, Govt. of India, New Delhi
- Sr. Consultant, Advisor and Director (E&F), Planning Commission, Govt. of India, New Delhi
- Director, SACON
- Director, Keoladeo National Park
- Divisional Forest Officer, Bharatpur
- Academicians and faculty members of various institutes in Rajasthan
- Officials from various line departments of Govt. of Rajasthan (Agriculture, Irrigation, Water Resources, Census, Directorate of Economics and Statistics), Central Ground Water Board
- Officials in the library of SACON, WII, Aligarh Muslim University, and Rajasthan University
- Colleagues and research scholars of SACON

Thanks