Chapter 8
Impact Assessment of Land Use Land Cover Dynamics and Population Growth on Food Security of Kashmir Valley, India

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Abstract Food Security is a diverse phenomenon engulfing the whole Kashmir Valley. The study aims to assess the food security scenario in the Kashmir Valley with due attention on the fact whether there is any significant variation in the patterns of the area under the staple food crops and any increment or decrease in the production of these cereals. To fulfil the objectives of the study, changes in LULC parameters from 2001 to 2018 were evaluated, and the findings were statistically correlated to the growth rate of the population. Food requirement was estimated according to the standard norms set by the Indian Council of Medical Research (ICMR) to find out the deficient districts of the valley. Our study revealed that paddy and maize are losing their ground and further marking a negative growth rate. Only four districts Baramulla, Kupwara, Budgam, and Anantnag contribute overwhelmingly share in the area of paddy and maize. Contrary to that, Srinagar, the summer capital having the maximum tendency towards urbanization has not a good share of the area under these crops. A similar pattern is displayed by the Shopian because a vast stretch of arable land in the region has been brought under the horticulture as it bears the best feasibility support for the fruits supplemented with the favourable geo-climatic conditions. According to the study, Srinagar 94.29% and Shopian 95.32% had reached the alarming levels of food deficiency in the Valley and are the two worst-hit regions in the study area. Furthermore, another southern district that is Pulwama, which was a food surplus in 2011–12 is now at its worst food deficiency 62.06% (2017–18). Our results indicate that except Bandipora (which has the surplus food of −25.70%) no other district is self-sufficient in food grains. In a matter of grave concern, Kashmir valley as a whole is facing 74.63% deficiency of food grains in 2017–18.

Keywords Food security · LULC · Food deficiency · Kashmir valley · Remote sensing and GIS

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8.1 Introduction

Food, along with clothing and shelter is our prime and immediate need. An early man came into being about 10,000 years ago, but the struggle for this primary need is still going on. An increasing population with continuing consumption growth clearly demands more food for survival. This directly or indirectly results in the growing competition for the extraction of more natural resources like land, water, and energy. In addition to this overexploitation of resources, the negative impacts of food systems on the environment are increasingly becoming clear (Tilman et al. 2001; WRI 2005), which must be tackled with the utmost importance. Rapid population growth and enhancement in developmental activities have critically intensified resource depletion and environmental degradation ((Shaw 1989; Jodha 1990; Harte 2007). The Continuing global population is yet likely to plateau with about 9 billion people by the middle of this century. This continuous growth rate of population with continuing consumption growth means bringing more and more land under agriculture as the global demand for food is increasing with every coming day. According to the data released by National Sample Survey (NSS), there is a sharp decline in per capita consumption of cereals since the early seventies (Rao 2000). Several local level determinants like house constructions, increasing urbanization, population growth, and other non-food agricultural land uses have resulted in food supply reductions (FAO 2009a, b). The world is facing a threefold challenge in terms of rapidly changing demand for food and its supply, this level of production in such a way that is socially and environmentally suitable and to ensure that no one in the world will longer remain hungry. Such a challenge requires changes in the way of food production, processing, storage, distribution, and access to the population. But there is a threat to such issues by the effects of climate change and concerns about how the measures of adaptation and mitigation may affect the food system (IPCC 2007; Schmidhuber and Tubiello 2007a, 2007b).

After the World Food Conference of 1974, food security attained worldwide attention, which led to the development, evaluation, multiplication, and diversification of food security concepts. The concept of food security has been defined differently by different scholars with close to 200 different definitions, but the theme or crux of all of them is similar. Among the main definitions of food security, the most important, useful, and standard definition was given by Food and Agriculture Organization (FAO), "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Thus, in broader connotation, the concept of food security has four main dimensions—accessibility, availability, utilization, and vulnerability. The linkages between these dimensions of food security will determine how steady, adequate, and risk-free the consumption of food in a country is both at the individual as well as household level. Access, availability and stability determine food security of any country, state or region, and utilization of food (Schmidhuber and Tubiello 2007a, b; Ericksen 2008) and can be termed as the fundamental pillars for measuring food security. Each pillar has a particular

function for food security where access is measured by physical infrastructure (Taqi et al. 2017). It involves transporting food to market and per day calorie requirement. Further irrigation impacts imports of food and provision of land, lastly utilization deals withits human usage for calories intake, treating low weight among children etc. About 800 million people are poor in the world and are chronically undernourished, among them, children, which are under the age of five, constitute a significant portion (Fischer et al. 2002). In today's era of globalization and modernization, more than one in every seven people around the world are facing the problems of access to sufficient energy and proteins for their sustenance, and even more than this ratio are under the grave grip of different forms of malnourishment (Food and Agriculture Organization of the United Nations (FAO) 2009). The concept of food security is one of the nexus that embroils not only output, but also the process involved, not only production, but also its access to all, not only technology, but also policy, not only a global issue, but also a national one, not only national, but also a household issue, not only a rural type, but also of urban places, not only a case of amount, but also a matter of content (Serageldin and Persley 2000). Food security is such a phenomenon or type of environment in which the lowest quintile income groups have the least or near-zero chances of being exposed to famine (Peter 2000).

National Food Security Act (NFSA) ensures social and economic access at all times to adequate availability of food for all inhabitants in the country with a living dignity, but in spite of such strategies and initiatives, the problems of malnutrition and food security continue to persist in India. World's one-third of undernourished children are found in India, about 40% of its children are underweight, one-half are stunted, and one-third of women are also found in the category of underweight in India. The problems of micronutrient deficiencies with alarming rates prevail through its length and breadth (Joshi et al. 2011). The global population is estimated to cross the mark of 9.7 billion people by 2050 with India as the world's most populous country, overtaking China (UN 2015). In a country like India, where about one-half of children are found to be malnourished, and about one-third of its total populace is poor in one way or another, the concept of food security is of paramount importance. In the past decade, despite its noteworthy monetary economic development, the highest number of hungry people in the world is found in India where about 195 million people every day go hungry according to FAO. It's the home of about 795 million hungry people (25%) found in the world and 15% of its total population. As per the Washington-based International Food Policy Research Institute (IFPRI) official reports, India is ranked 97th out of 118 countries on the 2016 Global Hunger Index (FAO, Ifad, WFP 2015). Though as recommended by the World Health Organization (WHO) and the Indian Council of Medical Research (ICMR), the Government of India will provide food grains to millions of its poor people at subsidized rates across the country to ensure the required minimum energy provided by daily diet in terms of calories. But, unfortunately, most of the states reveal unwelcoming results because the food provided is not as per the norms suggested. This situation results in malnutrition and under nutrition deficiency mostly found in children and women. Similarly, Kashmir Valley is no exception to this state of phenomena.

Land use plays a vital role in all aspects related to different food systems that enable the concepts of food security ((Foley et al. 2005; Vermeulen et al. 2012). A shift in the general land use from cereals to non-cereals entails a decrease in the production of food crops, this process, in turn, results in indirect impacts on food security components, i.e., food supply deficiencies (Babatunde and Qaim 2010). In this era of civilization, the productive agricultural land has been continuously lost to soil erosion, urbanization, desertification, Stalinization, and other human uses with unsustainable land management (Nellemann et al. 2009; Ganaie et al. 2020; Jamal and Ahmad 2020; Sahana et al. 2020). The studies concerning food security and land use relationship are of vital significance when policy formulation is at sight. Here, in India, the problem of food arises because of the demand–supply gap (Grafton et al. 2015). There are several factors which are responsible for this demand–supply gap, but among them, land use is one of the most critical factors (Lambin et al. 2003) and is considered dominant in the assessment of food security (Verburg et al. 2013). This gap in various regions in terms of staple food has been amplified by shifting cropping land use (Hanjra and Qureshi 2010). To tackle the problem of food insecurity and poverty significantly, India needs 4–4.5% of agricultural growth rate (Rao and Radhakrishna 1997). The rapid growth of the human population and the use of land ruthlessly is a death trap to the fragile environs of the earth (Hardin 1968). Cropping land use dynamics result in crop diversification, where small farmers are found to be incompatible in maintaining household food security when new crop mix includes cash crops (Donovan and Casey 1998; Altieri et al. 2012). Many small land size farmers mostly of rural areas and many other food producers who are found at margins of net food producers and consumers are being affected by rising prices of food in a complex way, with some being harmed and some benefitting (Hazell and Haddad 2001). A significant change in various land use categories has undergone in the study area due to the rapid growth rate of population, urban growth, hit-and-miss infrastructural development, expansion of horticultural land at the cost of agricultural land which invidiously altered the food security in the Valley. The displacement of agricultural food crops by horticultural cash crops is the primary concern of small farmers where the availability of food gets affected (Marteen et al. 1996). Hilly areas are best suited for horticulture because of climate, topography, and soil as compared to agriculture. According to a study, there is a consistent decrease in annual precipitation in Kashmir valley (Shafiq et al. 2019), which is one of the dominant causes responsible for the conversion of agricultural land to horticulture. It is the horticulture here, which is the primary source of income (Sharma 2000). In Anantnag, Budgam, Bandipora, Kulgam, Pulwama, and Shopian districts of J&K, the vast area of paddy cultivation has been converted into the areas of rain-fed drylands (J&K ENVIS 2015).

To understand the sensitivity of the food security for the common masses in the present context, it becomes imperative to evaluate the district-wise food requirement and further to explore the food deficiency and to identify the vulnerable areas of food shortage across the length and breadth of the Kashmir valley. The focus was also laid to estimate the area under the main cereal crops, i.e., rice and maize and even a modest attempt was made to accesses the production scenario of these staple

food crops in the Kashmir Valley. In the present study, it is hypothesized that drastic land use land cover changes and human population growth are directly linked to food insecurity in Kashmir Valley. To fulfil the objectives of the study, changes in LULC parameters from 2001 to 2018 were evaluated, and findings were statistically correlated to the growth rate of the population to find the relationship. This work is entirely devoted to LULC change phenomena, human population growth, and food production to examine the probable impacts and causes on food security of Kashmir Valley.

8.2 Study Area

Kashmir Valley, the half-closed ecosystem, is indeed the gift of Jhelum River made up by its numerous tributaries by laying down the detritus brought from high mountainous areas and is united within every fibre of its being. It is located in a transition zone from the Gangetic plains of India to the mountainous zone of the mighty Himalayas covering an area of about 15,948 sq. km. Within geographical coordinates of 33°20′ to 34°43′N latitudes and 73°52′ to 75°42′E longitudes at an elevation of 1850 m above sea level (Fig. 8.1). It is approximately 135 km long and 32 km wide. Its economy is mostly centred on three main sectors: horticulture, agriculture, and tourism. The Valley provides a proper scope for cultivation of fruits and vegetable covering a variety of temperate fruits like apple, almond, peach, pear, plum, cherry, and apricot because of its fertile alluvial soil. Traditionally, rice is the staple crop of the Valley, though, wheat, corn, and barley are also grown. Over the past few years, Horticulture in the Valley is gaining momentum at the cost of agriculture land and contributes significantly in GSDP of the state about 7–8% ((Department of Horticulture(2011; Taufique and Khursheed 2018).

8.3 Database and Methodology

Remote sensing satellite data is one of the chief sources of information and plays a significant role in the assessment of land use land cover change detection of any region over a frame of time. Thus, to assess the spatio-temporal LULC change in the study area, satellite data Landsat 4–5 Thematic Mapper (September 2001), Landsat-7 ETM+ (September 2011), and Landsat-8 Operational Land Imager (September 2018) with spatial resolution of 30 m have been used. To achieve more accurate results, the remote sensing satellite imageries were selected on a seasonal basis by keeping the harvesting and vegetation characteristics in view because August–September is the period when we can easily differentiate agriculture and horticulture, plantation and horticulture, and in addition to this, the imageries are almost clouds as well as haze-free. In the pre-processing stage, all the imageries of the study area were rectified and georeferenced based on World Geodetic System Datum (WGS84) to Universal

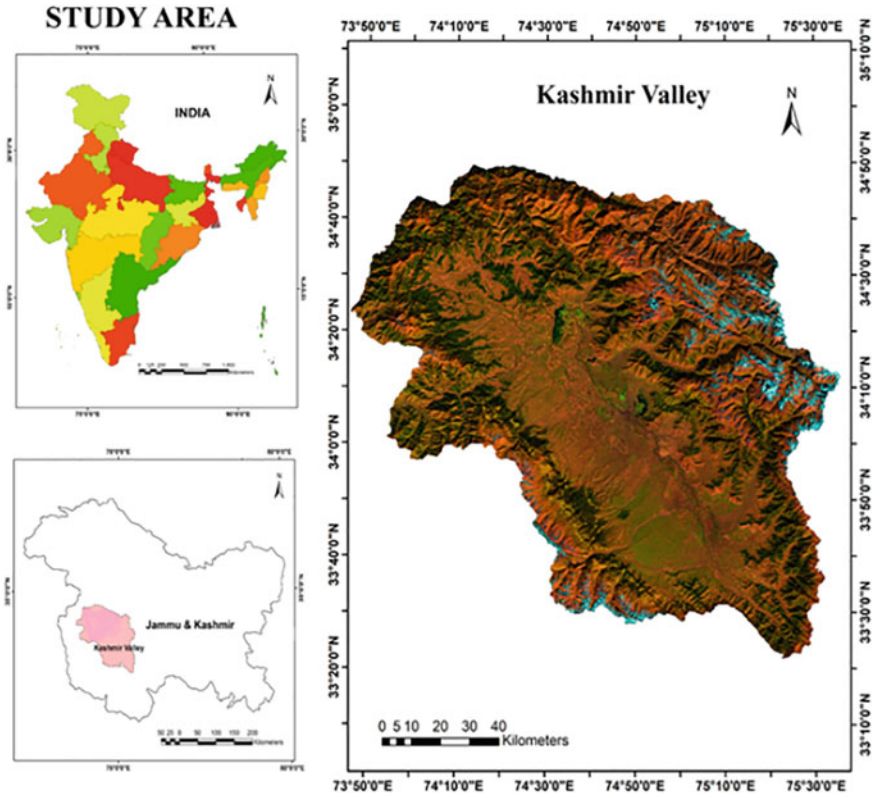

Fig. 8.1 Map of the study area, Kashmir Valley

Transverse Mercator Zone (UTM 43) in Arc GIS 10.5. Maximum Supervised likelihood classification was adopted to generate Landuse Land cover maps for the year 2001, 2011, and 2018 (Jamal et al. 2022). At various locations, about 150 spectral signatures for each category were opted to serve together as an identical measure to carry out the supervised classification for different LULC classes. Further, to reduce the errors and to improve to an accuracy level of the classification, Kappa accuracy was evaluated for each LULC maps produced from the Kashmir Valley. This Kappa statistics is considered to be the most reliable measure in terms of accuracy assessment (Cohen 1960; Jensen 2005; Lillesand et al. 2014). The accuracy assessment of satellite imageries used for the present study for the year 2001, 2011, and 2018 is given in the table (Tables 8.1, 8.2, 8.3, 8.4, 8.5, 8.6). This measure of accuracy assessment for the classified satellite imageries is calculated as (Bishop et al. 1977)

$$\Delta K \frac{N \sum_{i=1}^{r} xii - \sum_{i=1}^{r} xi + *x_{+i}}{N^2 - \sum_{i=1}^{r} xi + *x_{+i}} \tag{8.1}$$

Table 8.1 Accuracy totals for the year 2001

Class name	Reference totals	Classified totals	Number correct	Producers accuracy (%)	Users accuracy (%)
Water body	24	25	19	79.17	76.00
Crop	23	25	20	86.96	80.00
Vegetation	24	25	19	79.17	76.00
Dense forest	27	25	20	74.07	80.00
Sparse forest	26	25	21	80.77	84.00
Open	26	25	20	76.92	80.00
Built-up	24	25	20	83.33	80.00
Swamp	26	25	19	73.08	76.00
Totals	200	200	158		
Overall classification accuracy = 79.00%					
Kappa (K) statistics: overall Kappa statistics = 0.7600					

Table 8.2 Conditional Kappa for each LULC category (2001)

Class name	Kappa
Water body	0.7273
Crop	0.7740
Vegetation	0.7273
Dense forest	0.7688
Sparse forest	0.8161
Open	0.7701
Built-up	0.7727
Swamp	0.7241

Table 8.3 Accuracy totals for the year 2011

Class name	Reference totals	Classified totals	Number correct	Producers accuracy	Users accuracy
Water body	25	25	20	80.00%	80.00%
Crop	23	25	19	82.61%	76.00%
Vegetation	26	25	22	84.62%	88.00%
Dense forest	26	25	22	84.62%	88.00%
Sparse forest	27	25	23	85.19%	92.00%
Open	25	25	21	84.00%	84.00%
Built-up	24	25	22	91.67%	88.00%
Swamp	24	25	21	87.50%	84.00%
Totals	200	200	170		
Overall classification accuracy = **85.00%**					
Kappa (K) statistics: overall kappa statistics = **0.8286**					

Table 8.4 Conditional Kappa for each LULC category (2011)

Class name	Kappa
Water body	0.7714
Crop	0.7288
Vegetation	0.8621
Dense forest	0.8621
Sparse forest	0.9075
Open	0.8171
Built-up	0.8636
Swamp	0.8182

Table 8.5 Accuracy totals for the year 2018

Class name	Reference totals	Classified totals	Number correct	Producers accuracy (%)	Users accuracy (%)
Water body	24	25	21	87.50	84.00
Crop	24	25	20	83.33	80.00
Vegetation	27	25	23	85.19	92.00
Dense forest	26	25	23	88.46	92.00
Sparse forest	24	25	22	91.67	88.00
Open	26	25	23	88.46	92.00
Built-up	25	25	23	92.00	92.00
Swamp	24	25	22	91.67	88.00
Totals	200	200	177		
Overall classification accuracy = **88.50%**					
Kappa (K) statistics: overall Kappa statistics = **0.8686**					

Table 8.6 Conditional Kappa for each LULC category (2018)

Class name	Kappa
Water body	0.8182
Crop	0.7727
Vegetation	0.9075
Dense forest	0.9080
Sparse forest	0.8636
Open	0.9080
Built-up	0.9086
Swamp	0.8636

where

r = Rows in the matrix,

xii = Observations in row i and column i,

$xi+$ and x_{+i} = marginal totals of row i and column I, and

N = total number of observations.

The study is entirely based on secondary sources of data. The cereal crops of rice and maize constitute the staple food of the inhabitants of the Kashmir valley; hence their assessment and analysis have been taken into utmost consideration in this study. Thus, the data pertaining to these crops were collected from the Office of the Financial Commissioner Revenue Jammu and Kashmir.

In this study, the data regarding the population was also brought under attention to work out the requirement of food and deficiency of food, so this portion of the information was collected from the Census of India 2011. To estimate the projection of population for the year 2018, a simple athematic projection method was brought into purpose. The formula for that linear interpolation is

$$P_{\mathrm{p}} = P_1 + \frac{n(P_1 - P_2)}{N} \tag{8.2}$$

where

P_{p} = the Projected Population;

P_1 = present population according to recent census;

P_2 = Total population in the previous census;

n = Number of years from projection year and the previous census; and

N = Total number of years between the recent and previous census.

The food requirement was estimated according to the standard norms set by the Indian Council of Medical Research (ICMR, Dev and Sharma 2010). The agency has a fixed intake of rice and maize as 370 g per person per day. Hence, to find out these objectives, the following formula was brought into consideration:

$$\mathrm{FR}_y = T_{\mathrm{p}} \times I \times 365 \tag{8.3}$$

where

FRy = requirement of the food in a year;

T_{p} = Total population, and;

I = standard intake of food needed per person per day.

Deficiency of food in the study area was worked out through the formula eqn (4) from the data of domestic production of staple food crops obtained from the Office of the Financial Commissioner Revenue Jammu and Kashmir.

$$\mathrm{FD_y} = \frac{\left(F_\mathrm{t} - \mathrm{Dp_y}\right)}{F\mathrm{a}} 100 \tag{8.4}$$

where

FDy = Deficiency of food in a year;

F_t = Requirement of food; and

D_py = Domestic production in a particular year.

Karl Pearson's correlation method was applied to examine the relationship between population growth rate and various parameters of land use land cover of the study area.

$$r = \frac{n\sum x_i y_i - \sum x_i * \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2} * \sqrt{n\sum y_i^2 - (\sum y_i)^2}} \tag{8.5}$$

where

r = coefficient of correlation

x, y = the two given variables.

8.4 Assessment of the Main Crops of Kashmir

Rice, along with maize, has been the staple food of the inhabitants of the Kashmir from the times immemorable. These two cereal crops combinedly constituted a maximum area under its coverage, and thereby contributing enormously to fulfil the dietary and nutritional needs of the local populace of the valley. This has been the norm, but all of this has merely remained intact because of the widespread decrease in its area and the production which has been experienced by it. This downfall can be attributed to the large-scale diversification towards the high-value cash crops, particularly in the agriculture sector where vast tracts of land which were earlier meant for the paddy and maize were brought under the ambit of horticulture. The fallout has been on the rice fields of Kashmir and the agricultural life that was predicated on them. Even a couple of decades ago, Kashmir was an overwhelmingly agricultural society (Reshii 2012; Khursheed et al. 2017). This whole scenario has taken a toll on the food security of this region, and the future need for food, which is increasing with each passing day haunting a much-concerned pattern. Since, in this paper, we

are focussed on the assessment of the food requirement and the food deficiency in the Kashmir valley.

8.4.1 Area Under Cereals

Micro-level analysis of the area under the main agricultural crops of the Kashmir valley depicts a quite considerable variation across the length and breadth of the districts. In this context, the satisfactory performers consist of the two northern districts of Baramulla with 40,613 hectares and Kupwara with 35,888 hectares, Budgam with 29,180 hectares located in the central region, and also the Anantnag with 34,422 hectares which form the southern edge of the Valley. These four districts also owe their leading status to the much area which they acquire administratively. It can be observed from Table 8.7 that some districts of the area of interest also enjoy a good share of area under the coverage of rice and maize, these can be easily identified from the above-discussed Table 8.7 that Bandipora with 19,575 hectares, Kulgam with 16,441 hectares, Pulwama with 14,908 hectares, and Ganderbal with 11,765 hectares are worth mentioning. There are also some pockets in the valley besides having land in abundance but hardly contribute much to this share which can be used for the cultivation of main dietary cereals needed by the local inhabitants. From that point of view, there are two districts, Srinagar and Shopian, which attain the spot in this lowest category. Both of these districts, Srinagar with 2999 hectares and Shopian with 837 hectares, have separate reasons which drop them down to the bottom level among all the districts. Most interestingly, Srinagar is the summer capital of the state of Jammu and Kashmir that has much inclination towards urbanization, and prior to that, it has a very mere area under agriculture which pulls down it to the lowest level. Shopian, on the other hand, is popularly known for the horticulture crops, particularly

Table 8.7 Area, production and productivity of the rice and maize in Kashmir Valley (2017–18)

District	2017–18		
	Area (Hectors)	Production (Quintals)	Productivity (Quantal/Hector)
Srinagar	2999	109,036	36.36
Ganderbal	11,765	378,139	32.14
Budgam	29,180	953,941	32.69
Anantnag	34,422	1,229,575	35.72
Kulgam	16,441	491,708	29.91
Pulwama	14,908	329,934	22.13
Shopian	837	19,238	22.98
Baramulla	40,613	986,505	24.29
Bandipora	19,575	769,640	39.32
Kupwara	35,888	823,526	22.95

the apples. Thus, much of the land has been converted from the cereal crops to the much earning and prominent fruits in the form of diversification, thereby bringing its graph down.

8.4.2 Production of Cereals

Production as obvious and naturally is the outcome of the various inputs, and most importantly, the area under cultivation of the particular crop remains of the utmost concern. It can be observed from Table 8.7 that the production of the cereals has a fluctuating trend, and at the same time, presented an inconsistent pattern across every nook and corner of the Kashmir valley. As it has been found in the case of the area under the cultivation that there is no longer a uniformity across the districts in a similar fashion, the production figures are following a similar manner in most of the districts. Most handsomely production contributing regions coincide with the Anantnag, Baramulla, Kupwara, and Bandipora, among them Anantnag performed most progressively and attained the top spot in the best performers with the production above 12 lakhs quintal, thus it is the only district having such a voluminous production and crossed the mark of above ten lakhs. Its best performance is largely the outcome of the fertile tracts of land it acquires and the extensive land which it has brought under the ambit of agriculture. The northern stretch of the Kashmir Valley comprising three districts of Baramulla with 986,505 quintal produce followed by Kupwara with 823,526 quintal and Bandipora with 769,640 quintal constitutes a major chunk of the food production. Srinagar, however, has performed well with 109,036 quintal of production as it has the least area under these food crops, but it is too low as for as the demand for food supply in this district is concerned. The central part of the valley, i.e. district Budgam leads the production of above 9.5 lakh quintal, hence a good indicator for food prospectus of local population. In the southern belt of the study area, particularly Kulgam, which was once known as the *Rice Bowl* of Kashmir has produced 491,708 quintals of food grains in this period, whereas Pulwama with 329,934 quintal, and the lowest and the worst performer was the Shopian district, which contributed only 19,238 quintals of the cereal crop production. Their low-level performance in the output is evident and is strongly associated with the massive diversification of horticulture, particularly in these southern areas of the Valley. Hence, Kashmir, in general, and the districts having less area under the agriculture, in particular, will face a much more reduction in the production, therefore, in the very near future, the crops which constitute the staple food are going to meet the acute shortage, and these southern districts will find themselves on the worst side.

Food is considered among the basic amenities essential for the sustenance and growth of an individual (Jain 2016; Khursheed and Taufique 2019). It also focusses on all the dimensions of food security ranging from domestic production of food grains, including the availability and accessibility of these nutritional deposits. It also becomes imperative that their management is ponderous, and its handling is

executed in a definite and systematic way. Food security continuously remains a cause of concern and is set to haunt the millions of lives, and most ironically, it will have severe consequences on the nutritional and dietary needs of the people of Kashmir. Our study provides an in-depth view, and the results obtained are quite irritating, which are inhospitably against food security in this region. The study reveals that the valley of Kashmir is far away from the standard food production and the requirement as well as the ratio of deficiency is alarming. From the analysis of Table 8.8, it is very sad to note that district-wise figures show a gloomy picture.

The total food requirement in Kashmir was 59 lakhs quintal in 2011–12, and the same grew to more than 106 lakhs quintal in 2017–18. In a worrying trend, the food deficiency which was stationed at 36.47% fluctuated as high as 74.63% in the same period by a thumping increase of 38.16 points. Our findings also suggest that three districts in 2011–12 had a surplus food quantity; hence the deficiency was on a negative trend. This positive approach subsisted with Kulgam −13.12%, Budgam −10.72%, and Pulwama −2.57%. But in rest of the districts a deficiency ratio of 18.33%, 15.99%, and 62.06% in 2017–18, was found respectively. Pulwama along with the several other southern districts has put itself in dismay because of the large-scale conversion of agricultural land to the horticultural basket which has turned it food- sufficient to food-deficient over the years. However, districts like Shopian, Srinagar, and Pulwama are facing an acute shortage of food requirements. Srinagar is by and large at the same place where it was about eight years ago, but it experienced an increment of about 2% food deficiency from its previous records. Presently, Srinagar faces an intense shortage of food firstly because of its very rear domestic production and secondly the population explosion or the number of mouths it is supposed to feed is much more. Shopian is another grim reality of the food deficiency scenario

Table 8.8 Food deficiency and food requirement in Kashmir Valley 2011–12 and 2017–18

District	2011–12			2017–18		
	Population	Food requirement	Food deficiency (%)	Population (Projected)	Food requirement	Food deficiency (%)
Srinagar	63,980	1,670,337	96.17	1,413,431	1,908,838	94.29
Ganderbal	243,320	401,700	39.43	353,123	476,893	20.71
Budgam	1,127,030	1,017,932	−10.72	840,850	1,135,568	15.99
Anantnag	1,031,620	1,456,773	29.18	1,288,890	1,740,647	29.36
Kulgam	648,500	573,264	−13.12	445,802	602,056	18.33
Pulwama	776,310	756,874	−2.57	643,855	869,526	62.06
Shopian	37,030	359,523	89.70	304,633	411,407	95.32
Baramulla	912,130	1,361,356	33.00	1,108,240	1,496,678	34.09
Bandipora	370,080	529,709	30.14	453,374	612,281	−25.70
Kupwara	699,560	1,175,413	40.48	1,024,326	1,383,353	40.47
Total	5,909,560	9,302,885	36.47	7,876,528	10,637,251	74.63

that the Valley of Kashmir is facing. This region has put almost 90% of its area under horticulture, and hence the local production is very rare; in such a situation, the Shopian district is wholly dependent on the supply from the outside. This has recorded a 95.32% deficiency which is the maximum across all the districts of the Valley. Bandipora is the only district that showed a good record of food requirements and came out with surplus food. It recorded a negative deficiency of −25.7%, which is mostly because of the vast stretches of land converted towards agriculture and is encouraging.

8.5 Land Use/Land Cover

Land use and Land Cover (LULC) is an inseparable aspect and provides a comprehensive picture of any geographical region. Land cover corresponds to a physical description of Earth, leading to a simple definition: the observed physical cover of Earth's surface. This is what is overlaying or currently covering the ground. This description enables various physical categories to be distinguished—basically, areas of vegetation, bare soil, hard surfaces, and, according to the accepted concept of land, wet areas and water bodies (Duhamel 2012; Chrysoulakis et al. 2004; Burley 1961; Lesschen et al. 2005), while land use reflects a more complicated term inclusive with human activities such as the use of the land, industrial zones, residential zones, urbanization, agricultural fields, etc. (Chrysoulakis et al. 2004; Ellis 2007; Lo 1986). Human-induced land use/land cover (LULC) changes are among the most important process that shapes the dynamics of the ecological environment on the surface of the earth. This phenomenon, which is occurring at a bewildering rate, and its resultant environmental implications have become an essential area of research for scientists (Karimi et al. 2018; Hu et al. 2012; Jia et al. 2014; Liang 2008). Though the land use and land cover changes are the results of the interplay between socio-economic, institutional, and environmental factors, these changes put a strong influence on sustainability, food security, biodiversity, and the vulnerability of people on the Global scale (Lesschen et al. 2005; Brown 2015). Land use land cover has become a vibrant tool to monitor and access the varying trends across the spectrum of different land use categories. In this study, the same approach of assessment has been brought into consideration to analyze the changes. By processing the satellite images of three different periods of 2001, 2011, and 2018, several methods were implemented to delineate the categories of land use and land cover. Over this entire process, eight land use land cover classes were identified in the study area, these include Water bodies, Built-up, Agricultural land, Horticulture, Plantation, Snow, wasteland, and Forests.

8.5.1 LULC During 2001

Through the classification of the Landsat images of varied periods, the entire area mapped in the Kashmir valley was about 15,948.43 sq. km. An analysis of Table 8.9 and Fig. 8.2 and Fig. 8.5 reveal that the majority of the area in 2011 was covered by the green gold that is forested by an absolute value of 7459.67 sq. kms (46.77%) of the total study area. The other most important class is agricultural land which has acquired a share of 2456.76 sq. kms (15.40%). Snow has fallowed agriculture and has covered an area of 2271.36 sq. kms (14.24%). The observance of Table 8.9 also testifies that Waste Land dominates an area of 1589.89 sq. kms as (9.97%). Further moving ahead, Horticulture seems to be another major land use class by occupying a space of 893.44 sq. kms (5.60%). In 2001, the analysis reveals that Plantation was spread over 539.53 sq. kms (3.38%). Water bodies that constitute a significant role in the day to day life of any particular region recorded an area of 470.9 sq. kms (2.95%). Last but not least, the Built-up category came up with an area of 266.88 sq. kms which constitutes the lowest percentage (1.67) among all the classes.

8.5.2 LULC During 2011

Assessments of 2011 remotely sensed data depict that, among the eight classes of LULC, again forests have shown the maximum area under its coverage. It can be easily understood from Table 8.9 and Fig. 8.3 and Fig. 8.5 that forests occupied the top rank by covering an area of 7229.34 sq. km (45.33%). The very next dominating class was snow with 255.61 sq. km (16%). Agriculture land, which is vital for every society, has protected an area of 2387.28 sq. km (14.97%). The LULC statistic also indicated that during the year 2011, Waste land, which is not considered important has a share of 1595.29 sq. km with 10% under its ambit. From the observance of Table 8.9, it can be concluded that Horticulture with 958.67 Sq. Km, Plantation with 557.02 Sq. Km, and Built-Up with 305.08 sq. km, with an absolute percentage of 6.01%, 3.49%, and 1.91%, respectively, have dominated the scene.

8.5.3 LULC During 2018

A very recent Landsat image of 2018 was acquired and further processed in a fashion concurrence with our purpose of the study and the results obtained exhibit a significant picture of different land use and land cover classes. By evaluating the data presented in Table 8.9 and Figs. 8.4 and 8.5, clear-cut information is displayed regarding the several LULC categories. In a very positive development, forests are showing the majority of the area under their control; it ceases an area of about 6978.42 sq. km (43.76%). Snow-covered area fallows the forests and hence shares

Table 8.9 Statistics of land use land cover in Kashmir Valley, 2001, 2011, 2018

LULC categories	2001		2011		2018		Growth rate (%)		
	Total area (sq. km)	Total area (%)	Total area (sq. km)	Total area (%)	Total area (sq. km)	Total area (%)	2001–2011	2011–2018	2001–2018
Water bodies	470.9	2.95	364.11	2.28	256.26	1.61	−22.68	−29.62	−45.58
Built up	266.88	1.67	305.08	1.91	398.59	2.50	14.31	30.65	49.35
Agricultural land	2456.76	15.40	2387.28	14.97	2290.15	14.36	−2.83	−4.07	−6.78
Horticulture	893.44	5.60	958.67	6.01	1144.21	7.17	7.30	19.35	28.07
Plantation	539.53	3.38	557.02	3.49	515.38	3.23	3.24	−7.48	−4.48
Snow	2271.36	14.24	2551.64	16.00	2808.39	17.61	12.34	10.06	23.64
Waste land	1589.89	9.97	1595.29	10.00	1557.03	9.76	0.34	−2.40	−2.07
Forest	7459.67	46.77	7229.34	45.33	6978.42	43.76	−3.09	−3.47	−6.45
Total	15,948.43	100	15,948.43	100	15,948.43	100			

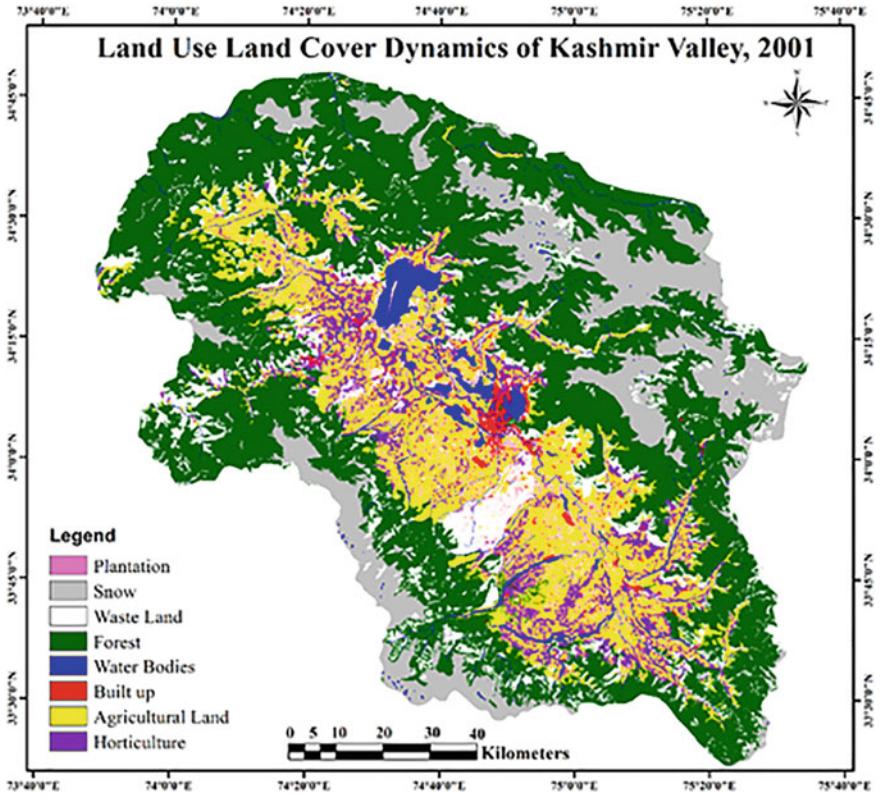

Fig. 8.2 Land use land cover map Kashmir Valley, 2001

an area of 2808.39 sq. km (17.61%). In yet another good indication, Agriculture Land occupies the third spot with 2290.15 sq. km (14.36%). In 2018, Waste Land also exhibits a share of 1557.03 sq. km (9.76%). Horticulture in an increasing trend over the previous data showed an area of 1144.21 sq. km (7.17%). Plantation with 515.38 sq. km (3.23%), Built-up with 398.59 sq. km (2.50%), and Water Bodies, the smallest land class with 256.26 sq. km (1.61%) are the prime LULC classes of the study area.

8.6 Change in the LULC

The modifications of the Earth's terrestrial surface by human activities are commonly known as Land use/land cover change (LULC) around the globe from the dawn of civilizations modifications have been carried out by humans, so that they can get food and other livelihood essentials for survival from the mother earth. But, the

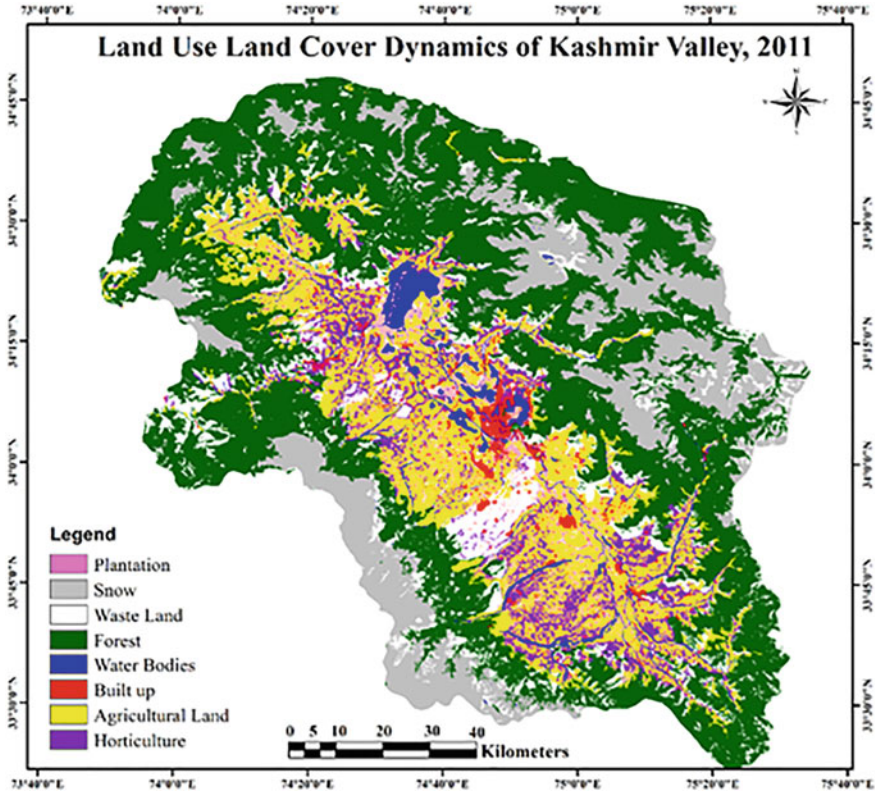

Fig. 8.3 Land use land cover map Kashmir Valley, 2011

extent, intensity, and rate of LULC changes are far higher than they were in the past (Hassan et al. 2016; Bucała 2014). In this present study, these land use and land cover changes were monitored to understand the changing dynamics of the different land use categories of the Kashmir Valley.

8.6.1 Change in the LULC 2001–2011

Changes in the LULC are evident during the period 2001–2011. During this tenure, there was the highest positive growth rate recorded by the Built-up at 14.31%. The snow-covered areas followed this as they arrived with the growth rate of 12.34% (Table 8.6, Fig. 8.2, and Fig. 8.6). The positive growth was also observed in the land use classes of Horticulture, Plantation, and Waste Land. Horticulture has increased by 7.30% during 2001–2011; this increase can largely be attributed to the inclination of the farmers to the cultivation of high-yielding cash crops. The plantation also grew

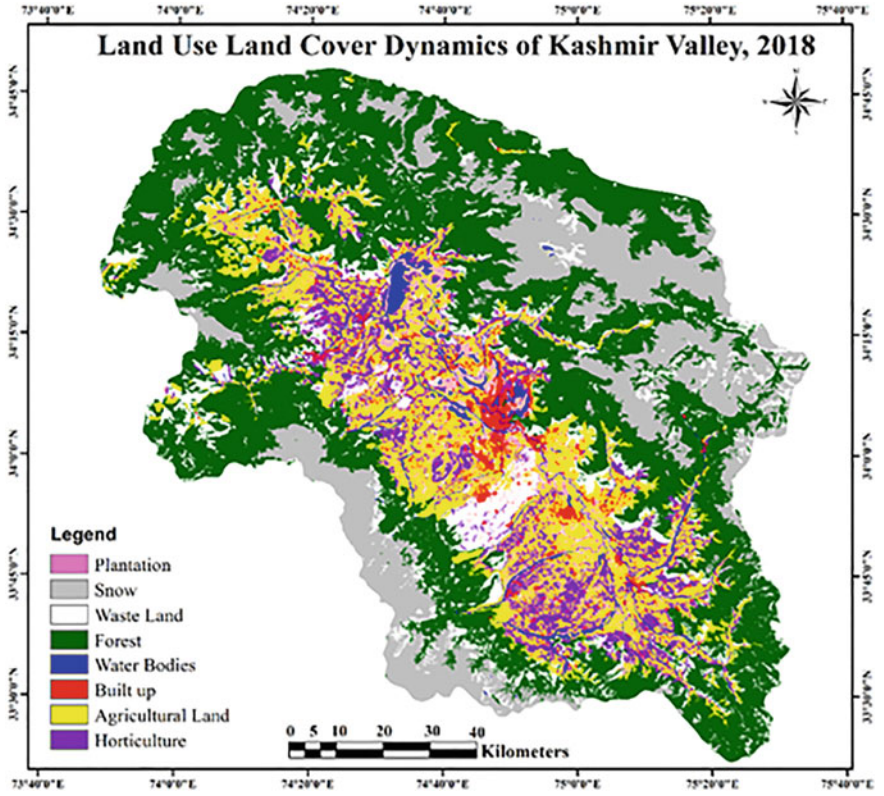

Fig. 8.4 Land use land cover map Kashmir Valley, 2018

with a rate of 3.24%, while the waste land was the least gainer among all the classes. In addition to this, their land use categories like Water bodies, Agricultural Land, and Forests depicted a negative growth. The reduction in all these three categories is a cause of concern for all the human population residing in the Kashmir Valley. The presence of water bodies has shrunk by −22.68% in this reference period. Another class, i.e., Forests which plays a crucial role in the survival of the human civilizations has reduced by the rate of about −3.47%. In a worrying trend, the Agricultural fields which recharge the granaries of the common masses and are responsible for the production of the important cereal crops have declined to the rate of −2.83% (Table 8.6, Figs. 8.6 and 8.2).

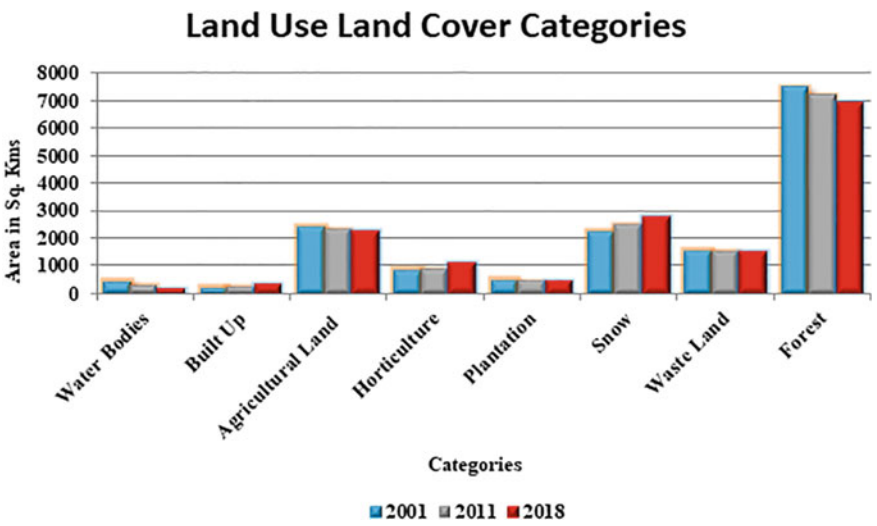

Fig. 8.5 Land use land cover categories of Kashmir Valley, 2001, 2011, and 2018

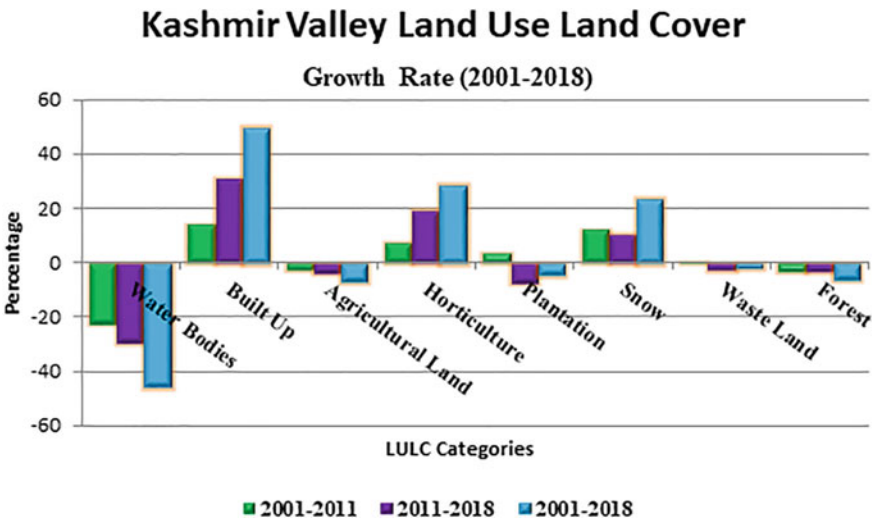

Fig. 8.6 Percentage change in land use land cover classes in Kashmir Valley 2001–2011, 2011–2018, and 2001–2018

8.6.2 Change in the LULC 2011–2018

Another period undertaken for the study consists of 2011–2018. During this period, widespread changes were observed across all the land use classes. The analysis of Table 8.6, Fig. 8.3, and Fig. 8.6 reveal that significant changes were exhibited

by Water bodies, Built-up, Horticulture, and Snow. In 2011–2018, the maximum positive change was achieved by the built-up areas with 30.65% as it is a natural phenomenon because of the increase in the human population and so is the impact on the built-up areas as more and more residential houses will be needed to fulfil the demands of this growing human count. Horticulture is another dominating land use class as it showed a growth rate of 19.35%, this sector is on the verge of development in the Kashmir valley because large tracts of the land are brought under the ambit of horticulture only to cultivate the highly cash-rich and productive fruit plants. This trend has positively contributed the horticulture, and thus, it becomes imperative for this land use category to extend its footprints. There were also some classes that arrived with a negative growth rate, the prime among them was Plantation with −7.48%, Agriculture Land with −4.07%, Forest with −3.09%, and Waste Land with −2.40%.

8.6.3 Change in the LULC 2001–2018

Changes in the land use land cover during the period between 2001–2018 was observed in the study area. The analysis of the data obtained from the (Table 8.6, Figs. 8.4 and 8.6) suggest that extensive growth almost in all the land use categories were recorded. The built-up class, with a maximum of about 49.35%, showed a tremendous positive growth rate. Likewise, Horticulture is another land use class that has gained superb attention from the local cultivation, and thus arrived with 28.07% growth rate. This growth has become a reality because of the availability of favourable geo-climatic conditions responsible for the growth and development of the fruits in the Kashmir valley. The horticulture sector is the primary land use class which has the most intensity to invade the other land use classes, particularly that of the Agricultural land. From Table 8.6, over these years, Horticulture is the third largest growing land use class in the Himalayan Valley. Built-up, the area as obvious, has the maximum tendency to increase has depicted a change of 30.65%. Another land use category that dominates the scene with a growth of 23.64% is the snow, but it is mostly confined to the upper reaches and is necessary to maintain the flow of water running in the rivers and streams. Again, during the time interval of eighteen years, the most crucial land use class, i.e., Agricultural Land has recorded a negative change of about −6.78%, while this has been mostly brought under the cultivation of the fruits. In a very alarming situation, the water bodies considered the lifeline of the settlements are declining at the rate of −45.58%, this is widely going to impact the day to day life of the people residing in this region. The plantation with −4.48% and Waste Land with −2.07% had decreased, but the area under horticulture and built up continuously expanded by a considerable margin.

The significance of the LULC patterns in Kashmir Valley was tested individually to check whether there was any relationship with the growth in the human population from 2001 to 2018. Pearson's correlation has been calculated to find the relationship between the change in land use and land cover patterns and human population growth

as given in Table 8.10. The results depict that there exists a strong relationship between the changing land use and land cover patterns and the changing growth rate of population during the study period, i.e., from 2001–2018. Built-up, horticulture, and snow show a significant positive correlation with the changing human population of $r = 0.943$, $r = 0.9.32$, *and* $r = 0.997$, respectively, suggesting that the area under these LULC categories got increased with the increase in the human population of Kashmir Valley. While on the other hand, Water bodies, agricultural land, forest, wasteland, and plantation have got decreased in their respective spatial extents with the growth in the human population. The value of r for different categories like water body ($r = -0.995$), agricultural land ($r = -0.981$), forest ($r = -0.992$), wasteland ($r = -0.728$), and plantation ($r = -0.492$), showed a significant negative correlation with the growth in human population indicating a decrease in their respective areas. From the table, it is clearly observed that the LULC changes in categories like water body and agricultural land were significantly ($p < 0.05$) related to the changes in human population growth, while in other categories like Built-up and horticulture, it was insignificant ($p < 0.05$) and related to the change in the growth of human population in the study area from 2001–2018.

8.7 Conclusion

In Kashmir, food insecurity is presently a challenging reality and the time is not far away when this shortage is going to become a threat to the existing human race as it has terribly taken a strong grip over the entire Valley. The vast level of socio-economic transformation has evolved out of the deficiency of food grains which is not only going to put tremendous pressure on the dietary needs of the local populace, but is also critically going to put its imprints on the socio-cultural fabric of the society. In our study, we focussed on the fact whether there is any significant variation observed in the patterns of the area under the staple food crops in the Kashmir Valley, and at the same time, it was also tried to access that is there any increment or decrease in the production of these cereals? Our study suggested that the most important food crops that are paddy and maize are losing their ground and further these crops are depicting a negative growth rate over these years. The production is also following a similar pattern. This analysis arrived with the fact that among the ten districts of the Kashmir valley, only four contribute overwhelmingly in the share under its coverage. These consists of Baramulla, Kupwara, Budgam, and Anantnag. But contrary to that, Srinagar, the summer capital having the maximum tendency towards urbanization has not a good share of the area under these crops. A similar pattern was displayed by the Shopian because a vast stretch of arable land in this region has been brought under the horticulture as it bears the best feasibility supportive for the fruits supplemented with the favourable geo-climatic conditions.

Food requirement and food deficiency are the prime contributing components that determine the levels of food security in a particular region. Food deficiency has not only increased, but it also has shown a quite worrying trend that some of the areas

Table 8.10 Relationship between changing LULC patterns and growth in human population in Kashmir Valley (2001–2018)

Correlations										
		Population	Water Bodies	Built-Up	Agricultural Land	Horticulture	Plantation	Snow	Waste Land	Forest
Population	Pearson Correlation	1	−0.995	0.943	−0.981	0.932	−0.492	0.997*	−0.728	−0.992
	Sig. (2-tailed)		0.066	0.216	0.125	0.236	0.672	0.048	0.481	0.080
	N	3	3	3	3	3	3	3	3	3
	*Correlation is significant at the 0.05 level (2-tailed)									

of the Kashmir valley are reeling under the threat of non-availability of food. Our study revealed that districts like Srinagar with 94.29% and Shopian with 95.32% had reached alarming levels of food deficiency; these are the two worst-hit regions in the study area. Furthermore, another southern district, i.e., Pulwama, which was a food surplus in 2011–12 is now at its worst food deficiency 62.06% (2017–18). Our results indicate that except for Bandipora (which has a surplus food of −25.70%), no other district is self-sufficient in the food grains. As a matter of grave concern, Kashmir Valley as a whole is facing a 74.63% deficiency of food grains in 2017–18.

There have been significant changes observed in the pattern of land use land cover classes from 2001–2018 in the Kashmir Valley because of the various anthropogenic and natural processes occurring in this part of the earth. Agricultural land which plays a crucial role in the production of food grains is continuously recording a negative growth of −2.83% in 2001 to −4.07% in 2011, to a further low of −6.78%.

Similarly, the land use categories like water bodies, Plantation, and waste land consistently showed a negative growth rate, but on the other hand, horticulture and built-up area arrived with positive growth. The horticulture sector, which is directly responsible for the encroachment and taking over of the agricultural land because of its expansion approach, has grown at the rate of 7.3%, 19.35%, and as highest as 28.07% in 2001, 2011, and 2018, respectively. The built-up area also recorded a growth of 49.35% in 2018. In a nutshell, the agriculture sector is on the verge of downfall and other land use categories, which hardly contribute to the positive development of food security, are on the way to blooming.

To assess whether there exists any relationship between the growing human population and the various land use land cover classes, thePearson's Correlation method has been brought to the place which testifies that there exhibit a stunning relationship between changing land use and land cover patterns and the changing growth rate of population during the study period, i.e., from 2001 to 2018. The significant positive correlation with changing human population was depicted with Built-up ($r = 0.943$), Horticulture ($r = 0.9.32$), *and* Snow ($r = 0.997$), thereby implying that the area under these LULC classes got increased with the increment in the human population. While the categories showed a declining trend with the increase in human number consisting of water body ($r = -0.995$), agricultural land ($r = -0.981$), forest ($r = -0.992$), wasteland ($r = -0.728$), and plantation ($r = -0.492$). It was further understood that changes in land use and land cover category like agricultural land were significantly ($p < 0.05$) related to the changes in human population growth. Thus, it can be concluded that the scenario of the food security in the Kashmir valley is irritating and its ill repercussions are slowly becoming evident. Therefore, if the proper measures were not brought into place, the fate of food security will no longer be away from its phase of dark age which is fast approaching day by day.

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Conflict of Interest The authors declared that they have no conflict of interest.

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