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LAND COVER CHANGES IN NORTHERN ZAGROS FORESTS (NW IRAN) BEFORE AND DURING IMPLEMENTATION OF ENERGY POLICIES

Hadi Beygi Heidarlou [a], Abbas Banj Shafiei [a], Mahdi Erfanian [b], Amin Tayyebi [c], and Ahmad Alijanpour [a]

[a]Department of Forestry, Faculty of Natural Resources, Urmia University, Urmia, Iran; [b]Department of Range and Watershed Management, Faculty of Natural Resources, Urmia University, Urmia, Iran; [c]Geospatial Data Scientist, Monsanto, Saint Louis, USA

ABSTRACT

Our ability to forecast future Land use/cover changes (LUCC) is extremely limited due to lack of understanding of how rapid and drastic changes like socio-economic shocks and disturbances (e.g., policy changes and economic crises) affect land use/cover. Energy policies changing in Iran have been implemented since 2010. In this study, we explored whether changes in energy policies affect the sustainability of forest cover and LUCC. Results showed that in the time periods of before and after implementation of the policies, 2,841 and 3,155 ha of forests converted to other land covers, respectively. It was also revealed that forest and rangelands degradation and their conversion to croplands and built-up areas have had the most contribution to increasing area of these land covers. Calculation annual rate of deforestation showed an increase in deforestation activities after the plan (−0.40% versus −0.53%). On the other hand, the population growth in the first period was 10,074 people, which was higher than the population increase in the second period (9,803 people). Therefore, it can be argued that the effect of the energy policies is likely to be greater than the increase in population and it appears to be able to cause a transition of land systems.

KEYWORDS

Deforestation; economic crisis; energy carriers; forest cover change; land Change Modeler; socio-economic disturbances; targeted subsidies plan

Introduction

Change detection is a process that makes it possible to observe and recognize the differences in the time series of phenomena, complications, and patterns of the earth's surface by changing socio-economic policies and demographics (Van Oort, 2007). Mapping and identifying land use/cover and its change using GIS and remote sensing techniques are of particular importance for policymakers, economic, natural resources planners. Degradation resulting from land use/cover changes (LUCC) and also land use management practices have the greatest impact on natural resources such as vegetation, water, food, and soil. Therefore, land-use information can help to solve natural resource management problems and can be a good guide for identifying critical areas in terms of the degradation and conversion of forests (Balthazar et al., 2015). Sustainable forest

CONTACT Abbas Banj Shafiei a.banjshafiei@urmia.ac.ir Department of Forestry, Faculty of Natural Resources, Urmia University, Urmia, Iran

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management (SFM) and forest cover changes are the UN's key goals to achieve sustainable development (Asibey et al., 2020). The fifteenth goal of UNs' Sustainable Development Goals (SDGs) refers to achieving protect, restore and promote sustainable use of terrestrial ecosystems (include the tundra, taigas, temperate deciduous forests, tropical rainforests, grasslands, and deserts), sustainably manage forests, combat desertification, and halt and reverse land degradation (United Nations, 2016).

In general, coupled human and natural system (CHANS), especially land use/cover, may have nonlinear responses to stressors and peak of the hazards that can shift systems to a new trend (Hostert et al., 2011; Rodrigues et al., 2016). Therefore, the dynamics of land systems may be determined as a result of the relative stability periods after rapid changes with long-term potential effects (Lambin & Meyfroidt, 2010). In the meantime, the most important challenge is to better understand the drivers that can organize land-use systems and change the long-term land-use trends (Plieninger et al., 2016). Disturbance in natural systems is considered an inherent part of it, which sometimes leads to a rapid change in the structure and functioning of the ecosystem (Hostert et al., 2011). This process may be occurred by slow drivers of changes (e.g., industrialization and demographic changes), fast drivers (e.g., revolutions, wars, pest infestations, socioeconomic shocks, technological advances), or both (Gounaridis et al., 2019). The impact of fast drivers on the conversion of land use/cover is not well understood, they may even strongly affect the current and future land systems and causes to increase or decrease of land-use intensity (Baumann et al., 2015).

Evaluation of the effects of social, political, and economic system disturbances on land use/cover empirically is rarely possible, but natural experiments can identify real-world conditions which are empirical-approximate conditions. These natural experiments can occur in the form of time discontinuities, that is, in short time intervals which one aspect of the system changes (e.g., the political system) while other aspects of the system (e.g., climate) remain constant and can, therefore, be controlled (Geist et al., 2006). Natural experiments can also use discontinuity in space, such as the boundary conditions in which political systems vary between two neighboring countries, while they have similar environmental conditions (Kanianska et al., 2014).

Investigation of socio-economic disturbances after the collapse of the Soviet Union (1991) and the Chernobyl disaster (1986) showed that many croplands were abandoned and after more than 20 years of these events forest expansion started to occur (forest transition) (Hostert et al., 2011). This study highlighted the role of national policies and institutions in coping with these socio-economic disturbances. Socio-economic disturbances can also result in an intensification and possibly unsustainable cases. For instance, the Asian economic crisis may have led to increasing forest degradation for rubber holding and oil palm expansion in Indonesia (Sunderlin et al., 2001) and may have contributed to the forest loss in the Chaco Region, Argentina (Zak et al., 2008). Social transformations in the Czech Republic caused excessive agricultural activities and 6% of the mixed forests were changed to pure broadleaf forests and 3.5% of the croplands have transformed into residential areas (Václavík & Rogan, 2009).

Demographic pressure has often been pointed as the main cause of LUCC, deforestation, and conversion of them to croplands and residential areas (Şen & Güngör, 2018). Historically, the most important land-use change that human beings have done is clearing forests for croplands and residential areas. The inverse relationship between population and forest area has been reported repeatedly (Li et al., 2015). The relation between population and deforestation in many developing countries has raised concerns about the decline in forest areas. Many studies have shown that deforestation related to the rate of population growth and responsible for global deforestation (Urgesa et al., 2016). In the history of humanity, the livelihoods of human communities are inextricably linked with forests (Swamy et al., 2018). This pressure depends on the development stage of each country and is influenced by their dependence on land (agricultural population), urban development, people's income level, and national policies (Tsering et al., 2019). Therefore, SFM and preservation policies directly oppose both community development and the use of forests (Bukoski et al., 2017).

In addition to environmental, demographic and political changes, targeted subsidies can also affect land-use systems by changing demand for biomass to use as biofuel (Krug et al., 2015). The implementation of targeted subsidies according to its vast inclusion and high socio-economic effects may affect all various sectors of a country (Long & Qu, 2018). The socio-economic reforms may influence natural resources and forestry sectors as well. Changes in the subsidy costs, the amount, the type, how to inclusion, allocate and distribute may have considerable effects on people's behavior and consequently on their life form (Papanastasis et al., 2017).

Targeted subsidies are one of the most fundamental decisions in economic development policies and a means of support for governments in order to balance the different sectors of production and consumption and various economic sectors in general (Koplow et al., 2008). Various countries such as Bulgaria, China, Egypt, Indonesia, India, Iran, Poland, Tanzania, and Turkey have experienced targeted energy subsidies and implementation of economic reform in various economic and social sectors (Doshmangir et al., 2015).

Iran has an upper-middle-income economy (World Bank, 2019) with a population of about 83 million people (Statistical Center of Iran [SCI], 2020). After the Iraq-Iran war, Iran initiated to develop five-year medium-term policies in order to increase socio-economic growth (Doshmangir et al., 2015). Iran experienced economic growth during the first (1989–1993) and second (1995–1999) periods of construction and structural reforms and a sudden increase in government intervention in economic affairs (World Health Organisation, 2006). During that period, targeted subsidies were considered as an economic policy by the Iranian policymakers. In the late 2000 s, the targeted subsidies policy was initiated by changing the trend of subsidy payments throughout the country by the policymakers (Doshmangir et al., 2015). In this regard, according to Article 95 of Iran's Fourth Development Plan, the government was required to enforce the comprehensive policies for poverty reduction and social justice to empower the poor through the efficient and targeted allocation of Social Security Organization resources and payable subsidies (Amuzegar, 2011). This economic reform was enforced in December 2010 (Hosseini et al., 2017). Through this plan, subsidy on some products including energy resources (i.e., diesel, gas, gasoline, oil, water) and some foods (i.e., bread, cooking oil, milk, rice, sugar, and wheat) were removed and they were provided at new prices (price increment) for all households in Iran (Zandian et al., 2016). The Iranian government also has implemented a direct payment cash subsidy system (450,000 Iranian Rials (IRR), equal to about 42 US$ in 2010, per person/per month on household head account) to all registered Iranian citizens to adjust their increased living costs (Brumberg & Farhi, 2016).

But because of the type of energy subsidy system in Iran, high-income groups benefit more than poor groups. On the other hand, the high amount of these subsidies in comparison with the Gross Domestic Product (GDP) in Iran, as well as the gradual liberalization of the price of energy carriers, has led to an increase in inflationary pressure on vulnerable populations. Based on experiments with the elimination of subsidies for energy carriers and bread in Iran, urban and rural household costs were increased by about 33 and 40 percent, respectively (Heidari & Parme, 2011). Hence, the expansion of poverty will have irreparable effects on the degradation of natural resources and forests (Messerli et al., 2015). In fact, due to local communities' dependence on forests and trees and to compensate for the financial shortage through deforestation and expansion of croplands, thus, this situation makes people more inclined to provide cheaper fuel from the forest (i.e., wood and firewood) and expand croplands.

Natural resources of West Azerbaijan Province in Iran and especially the forests of Sardasht city are important and relatively critical areas in terms of LUCC and forest declining in this province. So far, no research has examined the effects of socio-economic transformations on natural resources, especially land/forest cover changes. This has doubled the need for proper planning and review for this part of the country. Therefore, using Landsat time-series data, this study aims at reviewing and comparing the trend of land cover changes in Sardasht city considering socio-economic reforms and demographic changes during the period of 2002–2010 and 2010–2017. The choice of these time intervals has been due to time overlapping with the most important socio-economic transformation in Iran in recent years, namely, the targeted subsidies policy. Specifically, our study was conducted to answer the following research question:

- Have socioeconomic disturbances (i.e., targeted subsidies/energy policies) in Iran led to changes in land/forest cover?
- How was the trend of land cover changes before and during the socio-economic reforms and demographic changes in Sardasht?

Materials and methods

Study area

The Zagros semi-arid oak forests in western Iran are divided into three classes due to differences mostly between climate and species: 1) northern Zagros, 2) central Zagros, and 3) southern Zagros. Sardasht city as our study area located in West Azerbaijan Province and northern Zagros, NW Iran between 45° 13′ 48′′ to 45° 42′ 00′′ E longitude and 35° 57′ 36′′ to 36° 28′ 12′′ N latitude, with a total of 138,183 ha (3.8% of the province) (Figure 1) and 91,117 ha forest area which estimated by Iranian Forests, Range and Watershed Management Organization (FRWO) (Beygi Heidarlou et al., 2019). Palynological studies provide evidence that dry and irrigated agriculture, grazing and stockbreeding have occurred in the Zagros since the beginning of the fifth millennium BP (Djamali et al., 2009). At present, Sardasht forests are used for livestock grazing, browsing, defoliation and disbranching of trees as winter fodder for livestock. Other activities include collecting wood (for firewood, fuel, and construction), fruits, oak acorns, and converting forests to croplands (Varnosfaderani et al.,

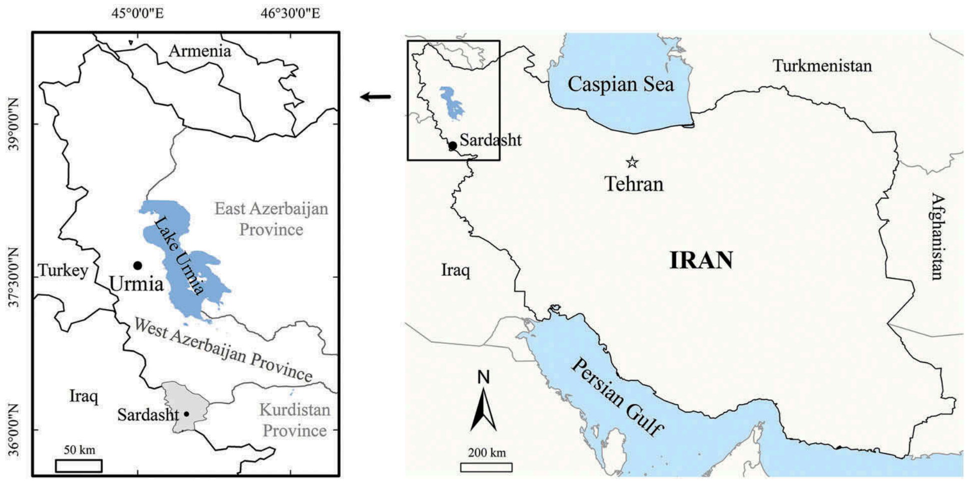

Figure 1. Geographical location of Sardasht city.

2017). More recently, fire frequency has increased in Sardasht due to human activities (Beygi Heidarlou et al., 2015).

The minimum and maximum height above sea level of the study area are 591 and 2,683 m. The average annual precipitation of Sardasht is 724 mm with an average maximum and minimum temperature of 21°C and 6°C in a 30-year period of time (1983 to 2013). The region's climate is semi-arid and Mediterranean. Also, based on the last population census of Iran in 2016, the population of this city was 118,849 people, in which the urban population (including Sardasht, Rabat and Mirabad cities) was 68,162 and the rural population (including 352 villages) equaled to 50,687 people (Beygi Heidarlou et al., 2019).

Land cover change (LCC) detection

In order to monitor land cover change (LCC) due to implementation of targeted subsidies plan in Sardasht, we used Landsat imagery because of its image availability and their spectral and spatial resolution are well suited for mapping land cover (Baumann et al., 2015). In this study, multi-temporal Landsat imagery was classified to extract land cover information and we selected the images for our change analysis based on seasonal coverage and cloud cover. The only cloud-free image data for the region in 2002 was available on September 06th. Subsequently, three-time points (2002, 2010 and 2017) selected for LCC detection and focused on two-time steps: 2002–2010, eight years before the implementation of the targeted subsidies plan (which captured the LCC before the implementation of the plan); and 2010–2017, seven years after the implementation of the targeted subsidies plan (which captured the LCC after implementation of the plan) (Table 1).

The land cover classes of interest were forest (canopy more than 5%, according to the definition of Iran's Forests, Range and Watershed Management Organization), croplands, rangelands, and built-up areas. For each of these classes, training data collected by visually interpreting of obtained Landsat images (Song et al., 2015); then land cover attribution of each point confirmed using high-resolution imagery in Google Earth (Baumann et al., 2015). These

Table 1. Details of used imagery for the study area.

Year	Data type	Sensor	Path/Row	Acquisition Date
2002	Landsat 7	Enhanced Thematic Mapper Plus (ETM+)	168/35	06 Sep
2010	Landsat 7	Enhanced Thematic Mapper Plus (ETM+)	168/35	31 May 19 Aug
2017	Landsat 8	Operational Land Imager (OLI)	168/35	18 May 23 Sep

training data used to classify Landsat images using a nonparametric random forests classifier (Breiman, 2001). Also, for post-processing step after classification we applied an iterative majority filtering to the classified output images in a 3 × 3 neighborhood around every cell in an input raster, which indicates an inappropriate classification (Coulter et al., 2016).

Thematic accuracy assessments of land cover maps for 2002, 2010 and 2017 calculated using confusion matrices (Tsendbazar et al., 2016) and stratified random sampling of 40 points for each class. Also, using high-resolution imagery in Google Earth, land cover of each point was checked by interpreting the Landsat images (Baumann et al., 2012). Then we built confusion matrices from sample counts by accounting for the class proportions of the land cover maps (Card, 1982). The area-weighted accuracy assessment and class-specific accuracies were then calculated using the method described by Olofsson et al. (2013). The variance and confidence level of the accuracies were derived using the equations for stratified random sampling based on a 95% confidence interval (CI) (Olofsson et al., 2013).

In the next step, in order to quantify LCC of Sardasht before and after implementation of the targeted subsidies plan, we used Land Change Modeler (LCM model) in TerrSet 18.7 software (Eastman, 2015). The LCM model can detect occurred rapid changes (e.g., socioeconomic disturbances) in a short period of time. This model is user-friendly, easily available and has a wide range of applications (Liang et al., 2017).

For this purpose, land cover maps were entered into the TerrSet, and change analysis including losses, gains, and net changes for each land cover class, and transition from one class to other type of land cover were evaluated for the first (2002–2010) and second (2010–2017) time periods using LCM model.

Annual deforestation rate

Deforestation rates for each time periods (e.g., before and after implementation of the targeted subsidies plan) were calculated using the formula below (formula 1):

$$dr = [A_2/A_1]^{\frac{1}{n}} - 1 \qquad (1)$$

Where dr is deforestation rate, A1 and A2 are forest cover in time period one and two, respectively, and n is number of years between time periods (Ellis & Porter-Bolland, 2008).

Population

In order to investigate the relationship between demographic changes and LCC in Sardasht over the studied time periods, population for the studied years was estimated using the data obtained from Statistical Center of Iran (SCI), with calculating Average

Annual Growth Rate (AAGR) of population during the census years, 1996, 2006 and 2011. The AAGR was also calculated using the following equation (Shryock et al., 1975) (formula 2):

$$AAGR = \sqrt[n]{\frac{P_n}{P_o}} - 1 \qquad (2)$$

Where Pn and Po are population at the end and the beginning of the period, respectively, and n is the number of years between the two time periods.

Results

Land cover mapping and accuracy assessment

The classification accuracy for our land cover maps obtained from Landsat imagery is provided in Table 2. The results show that each of the three land cover maps was in general highly accurate. The 2002 land cover map had the highest overall accuracy (0.91 ± 0.04) with a 95% CI, followed by the 2010 and 2017 land cover maps.

Change analysis

Figure 2 shows images representing spatial patterns for Sardasht for 2002, 2010 and 2017, and are quantitatively described in Table 3. Our results showed that forest area after the implementation of the targeted subsidies plan (2010–2017) has decreased by 3,155.04 ha (3.78%). While reducing the area of this land before enacting the plan

Table 2. Confusion matrices of the land cover maps for 2002, 2010 and 2017. Accuracy measures are presented with a 95% confidence interval. Land cover class 1 is forest, 2 is croplands, 3 is built-up areas and 4 is rangelands.

		Reference classes							
2002		1	2	3	4	Total	User's	Producer's	Overall
Map classes	1	35	1	0	2	38	0.92 ± 0.03	0.96 ± 0.01	0.91 ± 0.04
	2	0	36	1	1	38	0.95 ± 0.02	0.71 ± 0.13	
	3	1	1	39	1	42	0.93 ± 0.03	0.71 ± 0.11	
	4	4	2	0	36	42	0.86 ± 0.07	0.86 ± 0.06	
Total		40	40	40	40	160			
		Reference classes							
2010		1	2	3	4	Total	User's	Producer's	Overall
Map classes	1	36	2	0	2	40	0.90 ± 0.03	0.97 ± 0.01	0.89 ± 0.05
	2	1	36	0	4	41	0.88 ± 0.06	0.66 ± 0.15	
	3	1	0	39	0	40	0.98 ± 0.01	0.50 ± 0.22	
	4	2	2	1	34	39	0.87 ± 0.06	0.84 ± 0.07	
Total		40	40	40	40	160			
		Reference classes							
2017		1	2	3	4	Total	User's	Producer's	Overall
Map classes	1	34	3	0	2	39	0.87 ± 0.07	0.94 ± 0.01	0.86 ± 0.08
	2	0	34	2	2	38	0.89 ± 0.05	0.65 ± 0.17	
	3	0	1	38	1	40	0.95 ± 0.02	0.55 ± 0.24	
	4	6	2	0	35	43	0.81 ± 0.08	0.85 ± 0.07	
Total		40	40	40	40	160			

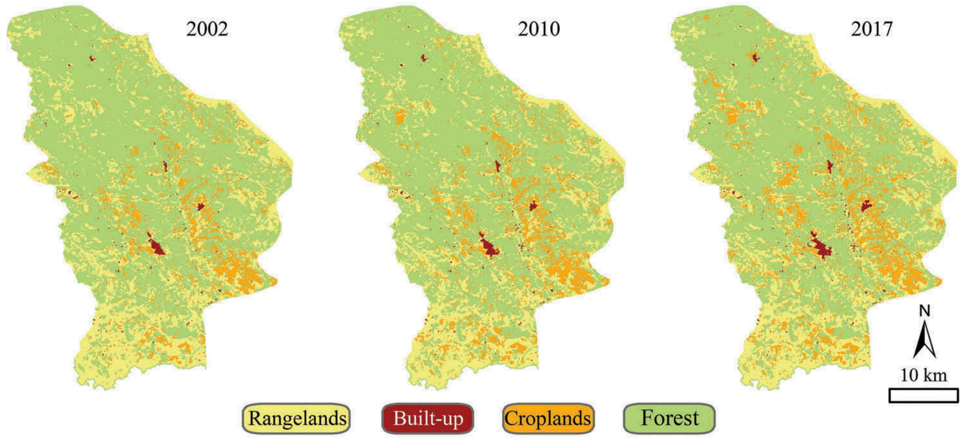

Figure 2. Land use/cover maps of Sardasht city for the years 2002, 2010 and 2017.

Table 3. Area of land cover classes and their percentage change during studied time periods (2002–-2010 and 2010–2017).

land cover class		2002		2010		2017
Forest	Area (ha)	89,401.77		86,561.1		83,406.33
	% change		−3.28		−3.78	
Croplands	Area (ha)	10,448.37		13,726.35		16,443.9
	% change		23.88		16.53	
Built-up areas	Area (ha)	729.54		925.74		1,107.36
	% change		21.19		16.4	
Rangelands	Area (ha)	35,626.41		34,992.9		35,248.5
	% change		−1.81		0.72	

(2002–2010) was 2,816.82 ha (3.25%). Overall, in the whole 15-year study period (2002–-2017), 5,971.86 ha of forest lands have been reduced. The results in Table 3 show that the development of croplands and built-up areas in the second period (2010–2017) compared to the first period (2002–2010) has been declined. So that, croplands increasing rate declined from 23.88% to 16.53% and built-up areas from 21.20% to 16.37% in the first and second periods, respectively. Also, rangelands before implementing the plan declined 1.81%, while the area of this land cover after implementing the plan, developed by 0.72%.

Table 4 and Figure 3 show change detection and the major trend of occurred net changes during time periods, before and after implementing the plan in each land cover class. Comparing net changes related to forestlands in the first period (2002–2010) showed that the amount of covered surface by this land cover has been reduced by 2,841 ha (−3.28%), and converted to croplands (1,592 ha), built-up areas (105 ha) and rangelands (1,144 ha). These changes after implementing the plan (2010–2017) increased, and there is an obvious trend of forest loss that 3,155 ha (−3.78%) of forestlands converted to croplands (2,414 ha), built-up areas (31 ha) and rangelands (709 ha).

Croplands expansion in the first and second period have been 3,278 ha and 2,718 ha, respectively. Also, 103 ha of croplands converted to built-up areas during the second period. Net changes for built-up areas for the first and second periods were 196 ha and 182 ha. Rangelands despite a decrease of 634 ha in the first period, due to conversion of

Table 4. Gains, losses and net changes for each land cover class for the periods 2002–2010 (before implementation of the targeted subsidy plan) and 2010–2017 (after implementation of the targeted subsidy plan).

			Forest	Croplands	Built-up areas	Rangelands
Losses	20022010	Area (ha)	−2,886	0	−3	−1,820
		% change	−3.23	0	−0.36	−5.11
	20102017	Area (ha)	−3,188	−2,593	−46	−1,923
		% change	−7.55	−18.9	−4.93	−5.5
Gains	20022010	Area (ha)	45	3,278	199	1,187
		% change	0.05	23.88	21.48	3.39
	20102017	Area (ha)	33	5,311	227	2,179
		% change	4.05	32.3	20.52	6.18
Net changes	20022010	Area (ha)	−2,841	3,278	196	−633
		% change	−3.28	23.88	21.19	−1.81
	20102017	Area (ha)	−3,155	2,718	181	256
		% change	−3.78	16.53	16.40	0.73

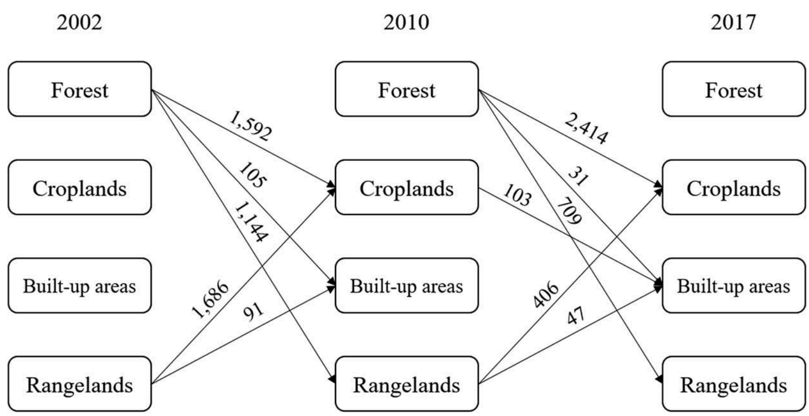

Figure 3. Major change trajectories among land use/cover classes and their contribution to net change in 2002, 2012 and 2017 (hectare of the study area).

forest, increased by 256 ha in the second period. During 2002–2010 and 2010–2017, the major changes for rangelands were conversion to croplands (1,686 and 406 ha) and built-up areas (91 and 47 ha).

Calculating deforestation rates (see Supplementary Table 5) for studied periods after and before implementing the targeted subsidies plan show definite and increasing deforestation activities and process in Sardasht with rates of −0.40% during the first period (2002–2010) and −0.53% during the second period (2010–2017).

Analysis of census data over the past years showed that the population of Sardasht from 93,176 in 1996 has increased to 118,879 in 2011. Also, the population of studied years using AAGR was estimated. Our results showed that the differences between population in the first period (2002–2010) was 10,074 and for the second period (2010–2017) was 9,803 (see Supplementary Table 6).

Discussion

Over the past years, the continual destruction and conversion of forests to other land cover types has been happening at a high speed, which has led to a decrease in forest areas. LUCC issues and reduction of the natural level of vegetation are due to the transition of forests to croplands by changing socio-economic policies (Aynekulu et al., 2006). The proper sustainable management of these areas requires the availability of up-to-date information about existing land uses and changes related to these land uses in different years, as well as the impact of ongoing policies and plans in these areas. On the other hand, according to the United Nations calling for global action to prevent deforestation, sustainable use of forests as well as promoting SFM (United Nations, 2016), this study despite the limited access to Landsat satellite imagery and actual population data (to calculate annual changes in both land cover and population) sought to examine a socioeconomic factor (targeted subsidies/energy policies) which has interacted to alter patterns of forest/land cover in the Sardasht region, Iran. It is important to integrate pre-crisis and crisis periods due to socioeconomic disturbances with remote sensing techniques in evaluating forest cover changes and trends in forest management. Our results showed that from 2002 to 2017, 5,995.44 ha deforestation occurred (Table 3). Investigating the changes occurred based on the time intervals before and after applying the targeted subsidies plan (Table 4) showed that the area of the forest after the implementation of this plan further decreased compared to the previous period (3.78%, 3,155 ha) and converted to other land covers in Sardasht. Meanwhile, the highest conversion from the forest was belonging to croplands, rangeland and built-up areas, respectively (Figure 3). The results of calculating deforestation rate (see Supplementary Table 5) also showed that annually −0.40% deforestation has occurred before the targeted subsidies plan while this value was subsequently reached to −0.53% after that, based on Figure 2, most of these degradations and conversions have been in the vicinity of forests and croplands and also in the vicinity of population centers (e.g., Sardasht, Rabat and Mirabad cities).

The results of this study showed that built-up areas have increased by 196 ha before the targeted subsidies plan. However, after applying this law and despite the increase in population (see Supplementary Table 6), built-up areas have less been growing (182 ha) compared to the time before it. On the other hand, the increase in population was observed in the first period (10,074 people) more than the second period (9,803 people) (see Supplementary Table 6), which can be a reason for the decline in the growth of built-up areas in the second period. Another reason for this issue can be due to government policy and also people's desire to live in multi-storeyed apartments and buildings which has increased in the second period of the study, especially through policies such as the "Mehr Housing Plan" in Iran (Yazdani et al., 2015). Figure 3 showed that the major changes in built-up areas were as a result of conversion from forests and rangelands which can be due to being free and higher accessibility natural areas. Destruction and deforestation in Sarabala (Ilam Province, west of Iran) around forests are due to their availability (Arekhi, 2014). Also, Yusefi et al. (2011) showed a decrease in the forests and increasing in built-up areas in Marivan city (west of Iran). Other experiences in Indonesia and Argentina also showed that problems in housing and economic issues in local communities have decreased the area of forest lands and increased deforestation (Sunderlin et al., 2001; Zak et al., 2008). Another example in the Neka watershed (north of Iran) showed that most of the forests lost have occurred on the margins of croplands that reflecting the role of human activities in deforestation (Shooshtari & Gholamalifard, 2015).

Comparison of forest changes during the years of 2002–2010 and 2010–2017 shows that forest degradation and transformation in the second period increased. Various factors can destroy these resources, that one of the most important of them is increasing in population and policies adopted by governments. The most important policy and practice that taken between 2010 and 2017 is targeted subsidies policy which implemented since 2010. On the other hand, population growth in the second period has not been the same as in the first period. Therefore, the role of implementing targeted subsidies plan in the destruction and transformation of forests can be considered more than population growth. There are other reasons for this, which requires more study. Despite the rising cost of energy carriers, the targeted subsidies plan has not been able to reduce the income gap and have an equitable distribution of revenues and it has caused the people to become poor. The most important role of poverty on land use is its impact on species habitat, carbon storage, and erosion (Messerli et al., 2015). Considering different income levels, this effect causes deforestation and forest degradation, and in poorer regions land transformation is occurred faster. Accordingly, using the experiences of this sample in Iranian northern Zagros forests and extracting the other main underlying driving forces can help reverse the permanent trend of deforestation and leads to appropriate policy-making in similar regions of the world after socioeconomic disturbances.

Conclusion

Overall, the results revealed that in spite of the implementation of targeted subsidies and energy policies since 2010 in Iran, forest loss in Sardasht forests has remained unabated. Comparing land cover data and maps over the two period of times before and after implementation of the policy associated with trends of land cover changes, represented a similar and rising trend in forest degradation.

It can be argued that the implementation of a policy that causes a large economic and social transformation (e.g., targeted subsidy plan), it can have different results in different areas. Especially if these areas are located in population centers and adjacent villages that depended on natural resources. Because any disruptive changes in the livelihood of the villagers will cause more damage to natural resources. Deforestation and by extension desertification adversely affect the livelihoods of forest-dwelling people. This is because these threats are continuous processes that require constant monitoring and evaluation. Hence, in such areas, special protection policies, such as the empowerment of local communities, should also be implemented. There is general agreement on the principle that along with implementing socioeconomic policies and conservation of rural forest ecosystems (e.g., Sardasht), the SFM and participation of local users who directly rely on the forest for subsistence needs to be required (Ali & Behera, 2015; Akamani & Hall, 2015). There is not much research in this area about definite and direct socioeconomic impacts of targeted subsidies policy on people’s life, so it is suggested to conduct more studies (biophysical inventory/survey) to ensure and help decision-makers in the country in order to interpret the results with higher confidence.

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ORCID

Hadi Beygi Heidarlou http://orcid.org/0000-0002-7070-6178
Abbas Banj Shafiei http://orcid.org/0000-0003-1832-4882
Mahdi Erfanian http://orcid.org/0000-0003-4142-411X
Amin Tayyebi http://orcid.org/0000-0001-5548-1129
Ahmad Alijanpour http://orcid.org/0000-0003-3389-930X

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