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Leibniz Institute of Agricultural Development  
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## **Research on Land Use Functions in Central Asia: A bibliometric analysis**

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**Abstract**

Agriculture is the backbone of Central Asia's (CA) economy providing economic and social stability in the region. Sustainable use of agricultural land is therefore of critical importance to economic growth, human well-being and social equity, and ecosystem services. However, severe land degradation through salinization, erosion and desertification is evident and respective impacts on human health and ecosystem services are suspected. This paper aims to analyze current research on agricultural land use in CA through applying the Land Use Functions framework. In particular, it examines the type and relative shares of environmental, economic and social aspects of agricultural land use addressed in existing scientific literature. This study analyzed scientific publications dealing with agricultural land use in five CA countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. A systematic database search of international peer-reviewed articles was conducted using the ISI Web of Science. We selected the English-language articles that were published between 2008 and 2013. After the analysis of paper titles, abstracts and keywords, we found 362 articles relevant to agricultural land use in CA. The analysis indicated that publications concentrating on environmental and economic dimensions of land use functions were primary focus of land use scientists. By contrast, social aspects of land use functions, such as employment, human health and recreational services, and landscape aesthetics received far less importance by international scholars. Interestingly, large portion of articles focused on issues of agricultural land use in Uzbekistan. This is due to the fact that the country extensively benefited from large international research projects in the last decade. By applying the Land Use Functions framework, we identified international research focus and knowledge gaps that future scientists can contribute to the sustainability of agricultural land use in CA.

**Keywords:** Land use functions, sustainable development, research gaps, agriculture, Central Asia.

**1. Introduction and Research Questions**

Central Asia (CA) possesses a well-known status in the region and internationally due to its geopolitical and strategic position. The five CA countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) became independent in 1991, and share a culture and a way of living enriched by many centuries of experience as the agents of social, artistic, scientific, religious and commercial exchanges between the East and the West (OLCOTT 1996).

Agriculture is the main source of income in rural areas of CA (BOBOJONOV and AW-HASSAN 2014). A steady increase of annual and winter temperatures in this region however, have caused significant impacts on agricultural production and land use practices (LIOUBIMTSEVA et al. 2005; FISCHER et al. 2002). Along with changing climates, transboundary water management issues have further resulted in a decline of agricultural production in the region (RAKHMATULLAEV et al., 2010). Advancing desertification and soil degradation in the Aral Sea area further impedes the region's sustainable land use (INDOITU et al. 2012). The increase of dust storms in the Aral Sea areas, particularly in southwestern part of Uzbekistan, is an additional challenge that impacts on human health (GROLL et al. 2013).

To address the challenges posed by climate change, water conflicts and other drivers of land use change, policy makers (international and domestic institutions) as well as land managers need an adequate knowledge base. Research can provide a knowledge base for well-informed decision making and help to close existing knowledge gaps. A meta-analysis of existing scientific literature helps to identify the research focus. Blind spots in the research can be detected if research about all three dimensions of sustainability (environmental, economic and social) is analyzed.

The *Land Use Functions* (LUFs) framework helps to include all three dimensions of sustainability into land use decisions. It was developed to make the concept of multifunctional land use operational for land use decision making and land management (PÉREZ-SOBA et al. 2008). It facilitates the assessment and governance of land use to promote sustainable development. This study is unique in connecting a meta-analysis about agricultural land use in the CA region with the LUF framework and therefore, it is a first step in efforts to close existing research gaps.

Thus, the main objective of this paper is to analyze current international research on agricultural land use in CA through applying the *Land Use Functions* analytical framework. In particular, it examines the type and relative shares of environmental, economic and social aspects of agricultural land use addressed in the international research community. Last but not least, the paper aims to identify existing scientific gaps for potential future research on sustainable land use.

## **2. Data and Methods**

This research used international scientific literature dealing with agricultural land use in CA. A systematic database search of peer-reviewed articles was conducted using the ISI Web of Science. We selected the English-language articles that were published between 2008 and 2013. We used the following thematic search terms in the database: agriculture, farm, irrigation, land, land use and water management. In terms of geographic search keywords, we used Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Central Asia. Documents were considered relevant if they matched at least one of the regional search terms and one of the topical search terms in title, abstract or keywords.

In this study, the original definitions of land use functions (PÉREZ-SOBA et al. 2008) were specified in accordance with the regional and sustainability context of our research question (Appendix A). For instance, the research about implementation of large-scale irrigation projects, management of physical infrastructure and issues related to transboundary water conveyances in relation to land use practices were included under LUF 6 'transport/infrastructure'. Moreover, provision of financial services and access to rural banks for agricultural farm management as well as land competition associated with agriculture were coded under LUF 5 'market and land independent production'.

## **3. Main results and Discussion**

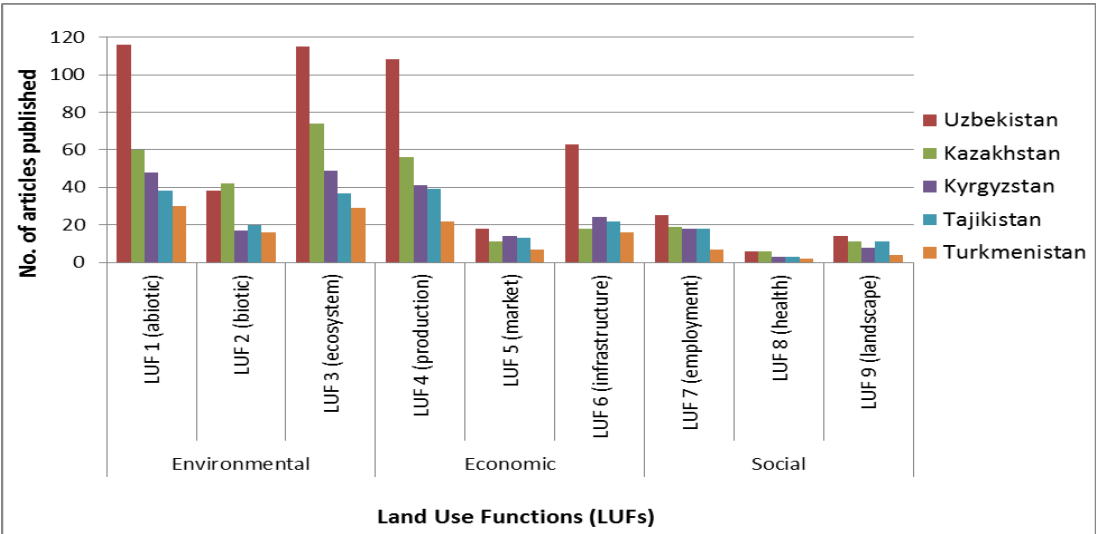
After detail review and analysis of paper abstracts, we found 362 articles relevant to agricultural land use in CA and they were assigned to land use functions. Distribution of LUFs across different countries is given in Figure 1. It can be seen from the figure that the country

ranking in terms of number of publications covering different types and relative shares of LUFs was led by Uzbekistan (219 papers covering 503 types of LUFs) and then, Kazakhstan (144 papers covering 297 types of LUFs). This is surprising at first hand because the area of agricultural land is far larger in Kazakhstan than is in Uzbekistan. On the other hand, Uzbekistan benefited from an extended German research project on land and water resources, where local and international scholars were highly involved. The project was implemented through the Center for Development Research (ZEF) at the University of Bonn during 2000-2011 with the financial assistance from the German Ministry of Education and Research (BMBF). In addition to that, International Water Management Institute (IWMI) has been very active since the beginning of 2000 in promoting research activities in the Ferghana Valley of Uzbekistan to implement an integrated water resources management approach. Thus, top-two institutions that authors come from include ZEF and IWMI.

In the meantime, the analysis of LUFs indicated that most scientists primarily focused on the importance of environmental and economic dimensions of land use. Going back to the ZEF project, for example, we can see that almost half of the papers deal with irrigation-related issues in the Aral Sea Basin. Most papers focus on the improvement of ecological conditions as well as agricultural production with limited available water resources.

Looking at Figure 1, one may also note that provision of abiotic resources (LUF 1) meaning that the role of land in regulating the supply and quality of air, water and minerals has been the main focus of land use scientists in recent years. The same can be illustrated for the maintenance of ecosystem services (LUF 3). However, support and provision of biotic resources (LUF 2) remains underexplored. Figure 1 also indicates that Kazakhstan papers were concerned relatively more on biotic resources and biodiversity (LUF 2) compared to other countries. This may be explained by the fact that much of the Kazakhstan’s economic growth is currently driven by oil and gas sectors (PETRICK et al. 2014), while agriculture is one of the lowest GDP contributors to the national economy of Kazakhstan. Due to the country’s concern with eradication of the Aral Sea disaster, the country’s focus shifted towards restoration of wetlands and fisheries in the vicinity of the sea (WORLD BANK 2010). Consequently, the role of land use for supporting biodiversity received higher attention compared to economic functions.

**Figure 1. Distribution of land use functions across different countries of Central Asia**



Source: Authors

Moreover, land-based production (LUF 4) received significant attention among land use economists, particularly in Uzbekistan and Kazakhstan, compared to market (LUF 5) and infrastructure (LUF 6). Having said that however, we can observe that provision of infrastructure was the main thematic area in Uzbekistan for most scientists. Detail review indicated that reconstruction and rehabilitation of irrigation and drainage infrastructures were primary concerns of most papers. DEAR et al. (2013) argue that in the context of CA, researchers that address socioeconomic aspects of agriculture often do not include any connection to land use, land management and ecosystem services.

Finally, when comparing the distribution of LUF-related publications on economic versus social dimensions of sustainability, it becomes clear that the social sciences are generally underrepresented. Social aspects, such as employment (LUF 7), health and recreational services (LUF 8), and landscape aesthetics (LUF 9) were far less important for international scholars. Surprisingly, despite the fact that the region experiences significant health problems as a consequence of soil salinization and land degradation (GROLL et al. 2013), only 14 articles (4%) addressed the impacts of land use and degradation on human health.

#### **4. Conclusions**

Through applying the *Land Use Functions* framework we identified research focus and gaps that future scientists can contribute to the sustainability of land use practices in Central Asia. The analysis of Web of Science-based peer-reviewed international journals covering the period of 2008-2013 indicates that most publications focus on the importance of environmental and economic dimensions of land use. Within environmental aspect, provision of abiotic resources (e.g. physical and chemical properties in soil and water) as well as maintenance of ecosystem processes (e.g. land degradation and grassland management) has been extensively addressed. Support and provision of biotic resources (e.g. habitats for fauna and flora, and organisms) were of least concern. Therefore, it is very important to shift future focus on support of local biodiversity in order to improve ecological conditions of the area. Economic dimension of sustainability showed mixed results. Provision of land for production activities (e.g. value chains, crop yields, and biomass production) as well as constructing and maintaining irrigation and drainage facilities to convey water resources have been the key issues of research. Support of rural banks, land competition and financial services were least addressed issues in the papers, which require more attention in going forward. Last but not least, societal aspects of sustainability have been far less addressed. This is clearly an evidence gap given the widespread impacts of land degradation on human health, particularly in the Aral Sea areas. Results suggest that although health issues associated with saline drinking water and dust storms are well known in the area, analytical linkage to land use is not made for mitigation purposes.

Going forward, it would be interesting to find out local key stakeholders and policy makers in the area of agricultural land use in Central Asia and undertake participatory workshop to get local perspectives with regards to land use functions. Through comparing different perspectives we may identify existing mismatches between the current research interests and the needs of key actors, which could further open up a new research interests. Finally, review of non-English articles shall be further explored.

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### Appendix A. Land Use Functions used in this study

Land use functions (LUF)	Definition	Adapted to the study
<b>Environmental</b>		
<b>LUF 1:</b> Provision of abiotic resources	The role of land use in regulating the supply and quality of air, water, minerals and soils.	Water balance, soil salinity, water and air quality, water and soil pollutants.
<b>LUF 2:</b> Support & provision of biotic resources	The role of land use in regulating the capacity of the land to support biodiversity, in the form of the genetic diversity of organisms and the diversity of habitats.	Habitats for fauna and flora, and organisms.
<b>LUF 3:</b> Maintenance of ecosystem processes	The role of land use in the regulation of ecosystem processes related to the production of food and fibre, the hydrological cycle and nutrient cycling, cultural services, and ecological supporting functions such as soil formation and carbon sequestration.	Ecosystem services, land degradation, soil fertility, pastures and arable lands.
<b>Economic</b>		
<b>LUF 4:</b> Land-based production	The role of land use for production activities that do not result in irreversible change, e.g. agriculture, forestry, renewable energy, and land-based industries such as mining.	Crop yields, value chains, biomass production.
<b>LUF 5:</b> Market & land independent production	The role of land use for residential, social, and productive human activity takes place in a concentrated mode. The utilization of the space is largely irreversible due to the nature of the activities.	Market mechanisms, financial services, rural banks, property rights on land.
<b>LUF 6:</b> Transport / Infrastructure	The role of land use for provision of space used for roads, railways, and public transport services, involving development that is largely irreversible.	Management of irrigation and drainage infrastructure and issues related to the transboundary water conveyances.
<b>Social</b>		
<b>LUF 7:</b> Provision of work	The role of land use for employment, quality of jobs, job security, and location of jobs (constraints, e.g. daily commuting).	Provision of job opportunities, income, livelihood security.
<b>LUF 8:</b> Human health and recreation (spiritual & physical)	The role of land use for health and recreational services, and factors that influence service quality.	Human health, nutrition, food security.
<b>LUF 9:</b> Cultural (landscape identity, scenery & cultural heritage)	The role of land use for landscape aesthetics and quality, and values associated with local culture.	The use of landscape for the purpose of cultural heritage and diversity. The issue of gender in land access.

Source: Modified from PÉREZ-SOBA et al. (2008: 382–383).