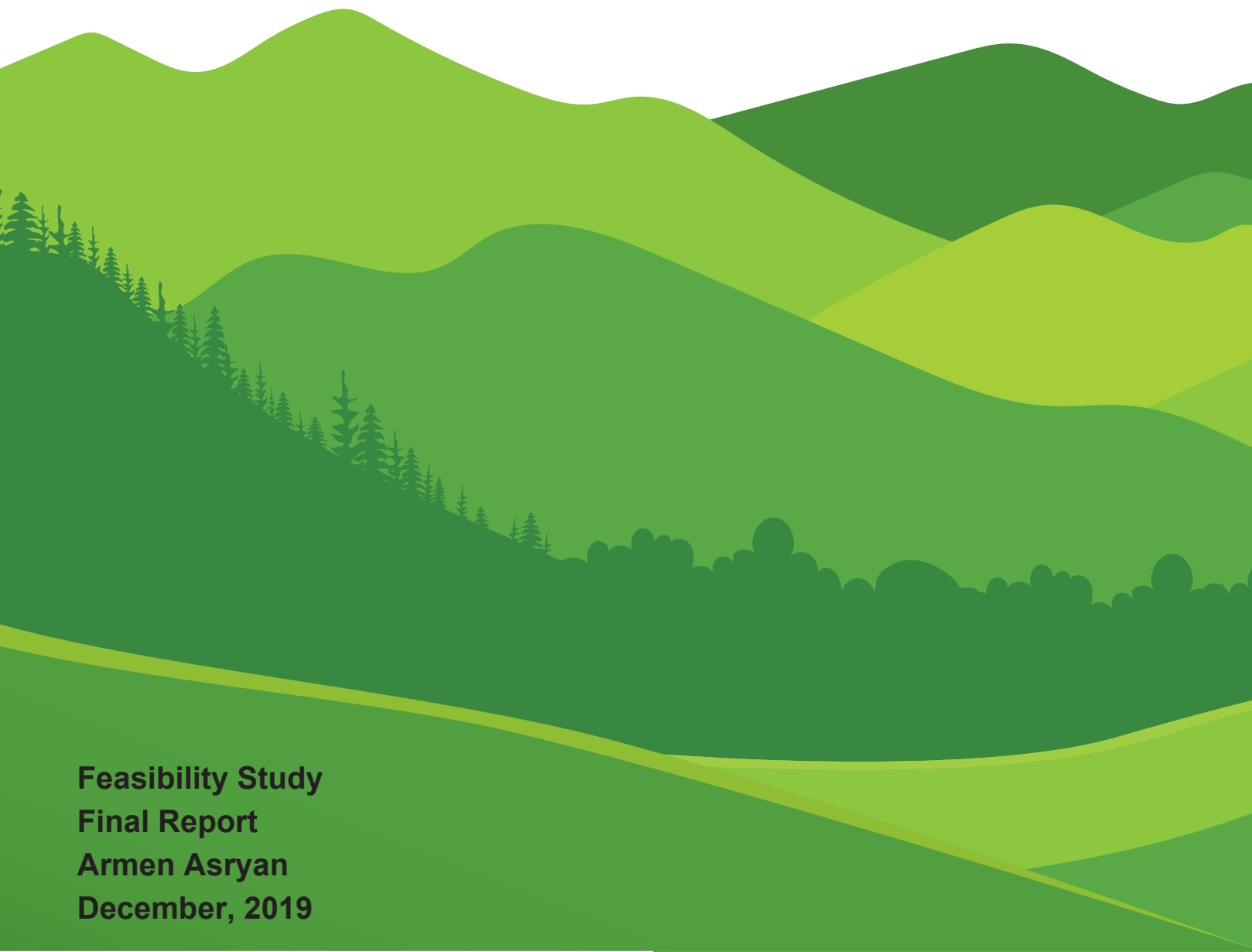
MINISTRY OF ECONOMY OF RA

MINISTRY OF TERRITORIAL ADMINISTRATION AND INFRASTRUCTURE OF RA

Գերմանական համագործակցություն
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Pasture and Grasslands Information System



Feasibility Study
Final Report

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December, 2019

Executive summary

This report details feasibility study findings and results on the necessity and viability for creation of a pasture and grasslands information system in the framework of a wider Agricultural land use management information system considered by the Ministry of Economy (former Ministry of Agriculture). The latter considered as a vital instrument for the management and monitoring of the agricultural land use. The feasibility study is the first step towards the development of the proposed Pasture Information system, which is included into the EcoServe program, where "Support to the development / improvement of a Pasture Information Management System (PIMS)" is an indictor to "Output 1: The availability of data as a basis for decision-making for sustainable, biodiversity-friendly management of natural resources is improved".

Natural fodder areas, such as pastures and grasslands constitute 39% of the total territory of RA and 57% of the agricultural lands and are a vital resource for the livestock keeping and represent an important value for biodiversity and ecosystem services. In the meanwhile, with the condition of natural pastures and grasslands, being drastically deteriorated due to the not sufficient management practices the issue of sustainable management of natural fodder areas became important to consider from the integrated management approach, emphasizing the need and effectiveness of decision-making processes based on robust data.

The study examined the building blocks of the proposed system such as stakeholder scene including government and affiliated ministries, departments, science and academia, non-profits, represented by educational and research institutions, non-governmental organizations, private companies and local communities represented by regional community authorities, villages to gather and formulate the requirements of different user groups. The study also looked at the enabling environment such as capacities of key stakeholders and legal issues that could affect the development of operation of the system, the realistic bases, possibilities, timeframe, budget and road map.

The identified constraints within the enabling environment included lack of technical capacities within the suggested beneficiary institution, the immaturity of the overall operating environment, especially related to the lack of technical and financial capacities, lack of clarity and continuity with institutional setups, issues with data availability, quality and exchange practices.

Along with the identified issues and constraints, several pathways or options were considered, such as:

a) Development of a full and independent pasture management information system,
b) Integration with (becoming part of) similar and already existing or planned systems in collaboration with the corresponding stakeholders and
c) Development of an initial data-centric system with essential functionality coupled with capacity building for the beneficiary institution with the possibility of a scale-up in the future.
The feasibility study revealed overwhelming support for the proposed system within all three main clusters of engaged stakeholders. While generally concluding on a positive note the study also considered the institutional, technical and legislative constrains that would likely hamper the development and successful operation of the full-fledged system within the existing enabling environment.

The findings as well as the wide consensus among participating stakeholders led to the recommendation to create, as an initial phase, a basic, data-centric information system, which would form the backbone of the future system that would include transactional and analytical functionality in support of the management functions of the key stakeholders. Although the first

two potions were deemed not to be practical at the moment, they still represent a valid follow-on pathway for development at later stages of implementation, based on the results of the initial phase and the possible positive changes to the enabling environment.

The report concludes with a set of recommendations addressed primarily to the EcoServe programme of GIZ and the Ministry of Economy's Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use. The latter is suggested to take up the function of a host institution to uptake the leading role in the implementation and primary use of the proposed system. The recommendations aim at achieving tangible results within the shortest possible time period addressing the immediate needs of the key stakeholders in the near-term and building the foundation for a more advanced information system for the mid-to-long term period.

In particular, it is recommended to focus on the development of a basic data rather than transaction based information system coupled with targeted technical capacity building of the host institution and focusing on building EO, GIS capabilities as in terms of expertise so the hardware and software. The capacity building should include guidance for department heads and project managers to understand geospatial data sets, data products, platforms and tools that are relevant to functions of their units as well as automation of remotely sensed image processing and special indices derivation through development of scripts and models, including, for example, NDVIs and Soils Sensitivity indices.

To improve the enabling environment and ensure that there is no duplication of effort it is further recommended that the Department of Agricultural Programs Development, Resource Use and Cooperation Development establishes regular communication with the key stakeholders, in particular with the Ministry of Territorial Administration and Infrastructure, the Real Estate Cadaster Committee of Armenia, the Ministry of High-Tech Industry. With part of the rationale being the active tracking of existing projects and initiatives as well as those that are in the pipeline that may overlap with the proposed system both in terms of data and functionality. This cooperation should also include the Agriculture Statistics Division of the Statistical Committee of the RA on data exchange regarding cattle numbers per community and any other relevant disaggregated statistics on agriculture that would contribute to the analysis of pasture and grasslands pressure and studies of land degradation and soils erosion. Importantly, the cooperation should be extended to the Armenian National Agrarian University in view the considerable sectoral overlap and the opportunities for technical and scientific collaboration and resource sharing.

Importantly, the study recommends extending the cooperation with the communities through facilitation of field data collection using digital tools in the form of a mobile application. This would provide for higher levels of community engagement and ensure the timely flow of data and information between the information system and the community users. Data collection methods and interfaces would largely be based on digitized Manual for Monitoring of Pastures and the Guidelines for Development and Implementation of Sustainable Management Plans for Pastures and Grasslands (of the Sustainable Management of Biodiversity, South Caucasus programme). As part of the pilot project, the availability of a mobile application for field data collection and reporting that would allow streamlining and standardizing the monitoring processes with real-time data transfer to the proposed information system and subsequent visualization and analysis as required.

Overall, the result of the proposed intervention, in the form of a pilot project of limited scope, should be a noticeable improvement of the capacity of the department of Agricultural Programs Development, Resource Use and Cooperation Development in data collection, processing and analysis and its subsequent use for decision-making and policy formulation. These capacities

and good practices will serve as a solid foundation for the future scale-up of the information system in a direction dictated by the evolving situation, infrastructure and institutional frameworks and developments. Upon achieving tangible results and a positive experience and the system for the national fodder areas can be later amended and/or upscaled for the other agricultural land use.

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List of Abbreviations

ACE	Acopian Center for the Environment
ADF	Agricultural Development Fund (CARMAC ll-project).
ANAU	Armenian National Agrarian University
AUA	American University of Armenia
AVI	Advanced Vegetation Index
BMA	Bioresources Management Agency
BSI	Bare Soil Index
CARMAC	Community Agricultural Resource Management and Competitiveness project
EO	Earth Observation
ESA	European Space Agency
ESRI	Environmental Systems Research Institute
GIS	Geographical Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GSP	Global Soils Partnership
IBiS	Integrated Biodiversity Management, South Caucasus Programme
ICARE	International Center for Agribusiness Research and Education
ICT4D	Information and Communication Technology for Development
ISDTC	Information Systems Development and Training Center
LAI	Leaf Ara Index
MES	Ministry of Emergency Situations
MIS	Management Information System
MMIS	Municipal Management Information System
MODIS	Moderate Resolution Imaging Spectroradiometer
MoE	Ministry of Economy
MTAD	Ministry of Territorial Administration and Infrastructure
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategies and Action Plan
NDMI	Normalized Difference Moisture Index
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NFMIS	National Forest Management Information System
NPCRI	Normalized Pigment Chlorophyll Ratio Index
PIMS	Pasture Information Management System
RA	Republic of Armenia
RS	Remote Sensing
SDA	Strategic Development Agency NGO
SDC	Swiss Agency for Development and Cooperation
SDI	Spatial Data Infrastructure
SMB	Sustainable Management of Biodiversity Programme
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank

1. Introduction

Natural fodder areas – pastures and grasslands in Armenia are the vital resource for the livestock keeping and are foremost value for biodiversity and ecosystem services perspective. 39% of the territory of RA and 57% of the agricultural lands are occupied by natural fodder areas. The livestock keeping is a strategic direction of RA agricultural development. For the development of that sector the fodder provision is a key, and the main source of it in Armenia are the natural fodder areas. The condition of natural pastures and grasslands is drastically decreased due to the not sufficient management practices of pastures and grasslands in Armenia. The issue of sustainable management of natural fodder areas is important to consider from the integrated management approach, emphasizing the need and effectiveness of decision-making processes based on robust data. The improvement of the availability and quality of the data and information in pasture management field will increase the effectiveness of decision-making processes in this field, correspondently will improve the pasture management sector in Armenia. The achievement of that goal may depend on the creation of pasture information system, in the framework of the Agricultural land use management information system, considered by the Ministry of Economy (former Ministry of Agriculture) as a vital instrument for the management and monitoring of the agricultural land use and particularly pasture lands.

In the framework of sustainable development strategy of rural areas and agriculture 2017-2030 of RA, which states the main directions of state policy on rural and agricultural development, as a priority of livestock development field is highlighted the need for natural fodder areas (pastures and grasslands) sustainable use mechanisms. The need of sustainable use and restoration, conservation and improvement of the ES of natural fodder areas also reflected by different national and international strategic documents for the environmental field, such as NBSAP, UNCCD, UNFCCC, etc.

Towards improvement of fodder production in the framework of sustainable livestock management in rural areas of Armenia, the RA government adopted 2 governmental decrees in 2010 and 2011, to regulate the use and sustainable management of natural fodder areas. It is important to mentioned that those norms and regulations are not widely functional in rural areas of RA, they have been developed based on the average annual old existing data and not always are justified, doesn't exist a comprehensive up to date research and assessment of the condition of natural fodder areas for whole country. Towards implementation of the norms amended by the governmental decrees have been implemented and under the implementation are different governmental, as well as activities implemented by the national implementing and donor organizations for the sustainable management of natural fodder areas and fodder provision for the livestock keeping, on local and regional levels.

Pasture management methods have been developed by different projects supported by GIZ - SMB, IEC and IBiS, and the development of a Pasture Information and Management System (PIMS) has been envisaged – though not developed - by SMB program. In 2018, a Pasture Management Information System was included into the upcoming EcoServe program, where "Support to the development / improvement of a Pasture Information Management System (PIMS)" is an indictor to "Output 1: The availability of data as a basis for decision-making for sustainable, biodiversity-friendly management of natural resources is improved".

The need of such an information system/toolkit has been raised by different organizations working in this field in the framework of Pasture management platform, to ensure the effective decision making on national level towards sustainable pasture management, sustainability upscale and institutionalization of the already developed toolkits and implemented activities on local and regional levels for the sustainable fodder areas management field.

2. Stakeholder scene

In order to define the objectives of stakeholders a number of working meetings with relevant partners and interested parties were held to introduce the idea of the proposed pasture and grasslands information system, as well as to gather and formulate the requirements of different user groups. These discussions resulted in the development of consolidated and approximated personas, or in other words the user types, one per stakeholder cluster.

Meetings with a total of 17 organisations were held, including 40 individuals representing civil servants, industry experts, scientists, academics. Geographically, apart from the institutions located in the capital city of Yerevan, the study covered 12 villages in 3 marzes (Tavush, Syunik and Shirak).

Final discussion and presentation of the results of the feasibility study took place during the *"Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands" 5-th workshop* (September-17, 2019) and the received comments and recommendations were reflected in final outputs of the study.

Stakeholder scene in the field of pasture and grasslands use and management can be broadly grouped into three clusters such as the:

a) Government, affiliated ministries, departments, agencies;
b) Science and academia, non-profits, represented by educational and research institutions, non-governmental organizations, private companies;
c) Local communities represented by regional community authorities, villages.

2.1 Public Institutions

The stakeholders within the public institutions cluster included:

- **Ministry of Economy** represented (assigned focal point) by the *Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use*

- **Ministry of Environment** represented by the *Bioresources Management Agency* and the *Department of underground resources and land protection policy*

- **Ministry of Territorial Administration and Infrastructure** represented by the deputy-minister and the *Department of Local Self – Government Policy* and its *Division of management of Community Information Flows.*

- "Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands"

- **Real Estate Cadastre Committee of Armenia** represented by the *Geodesy and Cartography Department*.

- **Statistical Committee of the Republic of Armenia** represented by the Agriculture Statistics Division and the Information Resources Management and Technologies Department

The results of the discussions are consolidated and summarized in the following table:

Table 1: Stakeholder perspectives: The Government

	Ministry of Economy *Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use*
	• Lack of reliable data over subject matter • Concrete problems the department is facing: o Identification of unused pastures and grasslands o Availability of pasture and grassland data of land users (VAT, natural / legal person, ownership / lease / use, as well as cadastral code) o Delineation of irrigated and non-irrigated pasture and grassland areas o Presence of water feeders in pasture o Degree of degradation of pastures and grasslands o Numbers of livestock population in communities o Altitude above sea level and slope characteristics of pasture and grassland areas. • Importance of using publicly available spatial and non-spatial resources, including satellite imagery • Need for auxiliary datasets and maps to facilitate visualisation and analysis: irrigation, road network, water sources (for example water source data developed by CARMAC II), animal registration and tagging could also be helpful for monitoring erosion • Need to investigate the availability and specifics of other information systems at the ministry to avoid duplication.
	Ministry of Territorial Administration and Infrastructure *Deputy-Minister and the Department of Local Self – Government Policy* and its *Division of management of Community Information Flows.*
	The ministry is the executive authority, which elaborates and implements the Government's policy in the field of local governance and infrastructures. As such it oversees the Municipal Management Information System (MMIS) developed and maintained by the Information Systems Development and Training Center (ISDTC) NGO within the framework of the "Local Governance Programme South Caucasus" programme. The latter supports the development, upgrade and expansion of the system in Armenian municipalities and is led by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry of Economic Cooperation and Development. The MMIS is a data management and information system developed for local self-government bodies. It consists of management and administration subsystems, registers, information resources, e-services components, and internal and external communication tools. As a web-based system MMIS also provides the operation of the official websites of the municipalities and offers various online participation mechanisms. Within the feasibility study, the MMIS is viewed as a highly valued resource with potentially overlapping functionality and possibility for integration with the proposed pasture and grasslands information system.

	The ministry's standing on the proposed pasture and grasslands information system was positive with special emphasis placed on the interoperability of the future system, adherence to data standards, and collection and processing protocols. Other suggestions included: • Ensure system and data versioning, considering the likelihood of regular updates and corrections • Consider establishing cooperation with Ministry of High-Tech Industry to ensure adherence to the national strategy for the development and standardization of information and communication technology • Ensure that there is an ongoing and close cooperation with the Real Estate Cadastre Committee of Armenia in view of the current efforts in building the Integrated cadaster As well as receiving up to date cadastral records for pasture and other plot boundaries that could be relevant for the purpose • Pilot project – better have full coverage with few data types than partial coverage with more details. Thus, starting nationwide is the preferred option.
	"Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands"
	The discussion with the Platform served as the springboard at the beginning of the feasibility study providing perspectives on virtually all aspects of the work – technical, legal, institutional. The meeting conducted at GIZ premises revolved around the general problems facing the sector and highlighted a wide variety of issues that gave the consultant a good orientation prior to the meetings and discussions with other stakeholders. Among the topics discussed the following areas were prioritized: • Availability of irrigation water in terms of both the condition of the existing (or absence of) distribution network and the impact of the changes of precipitation patterns • Reliable information on the ecological condition of the pastures • Clearing the situation with data sources and suppliers, setting standards for data collection, sharing • Integration of the Manual for Monitoring of Pastures into the system through digitisation of data input and storage processes • Potential of using Management Plans as a baseline for fodder areas management performance measurement over time, and as a source of reliable information to the public in general and the private companies. • Opportunities for the private sector for harnessing the pasture and grassland resources in a more economically competitive and environmentally sustainable way, examples including valuable herbs and edibles collection, processing and sale. • Adequate mapping of pasture extents, quality, delineation of land-cover by types, mapping state vs community ownership lands, • Improper cadastral valuation of pastures that creates legal issues due to cadastral plots overlaps • Automation of community management practices as part of e-governance system and the importance of ensuring the use of the proposed system by the senior management of stakeholder organisations, including the monitoring

	tools of the proposed system and organising data flow from local communities to the central government • Consider engaging the ANAU as science basis of the system • Importance of integration of cattle statistics, working with the agricultural census, geotagging of animals for tracking grazing practices and pasture loading • Consider cooperating with efforts directed at mapping of forest areas, to avoid duplication Among other developments discussed was the upcoming *Agriculture Policy Monitoring and Evaluation Capacity Building Project* (funded by the WB) which has the objective to strengthen the Ministry of Economy's monitoring and evaluation capacity and systems to enable itself to carry out evidence-based agriculture policy analysis and formulation. Given the potential of overlap with the proposed pastures information system the progress of this project needs to be monitored for possible cooperation and integration at later stages.
	Ministry of Environment *Department of underground resources and land protection policy* * *Bioresources Management Agency* **
	* The *department of underground resources and land protection policy* highlighted the existing issues with mapping, measuring and monitoring desertification extents and rates as well as lack of data on soils erosion. The department is tasked with developing land restoration and recultivation policies and practices however, data gaps act as a serious impediment to their operations. There is no much link with the Armenian National Agrarian University concerning sharing of information on the technical (agricultural) aspects of pasture management could positively contribute to the quantification of the value and economic use of biodiversity resources contained within the fodder areas. Among its data and operational needs, the department cited: lack of soil monitoring capacities, pollution data, and effects of mining operations including dust. Having access to the Real Estate Cadastre Committee system, the digital base maps as well as facilitation of access to base data of the thematic atlases produced by the Institute of Cartography and Geodesy would be instrumental for the department. ** *Bioresources Management Agency* prioritized the use of information on species distribution over the pastures and grasslands as well as valuation of biodiversity as a factor when determining the values of the natural fodder areas. Such approach, in their view would encourage the development of alternative livelihoods and more rational use of the ecosystems (ecoservices, ecotourism).
	Real Estate Cadastre Committee of Armenia *Geodesy and Cartography Department*

	The department expressed its willingness to support the proposed system within the envisaged integrated cadastre, the concept of which had been developed in compliance with Real Estate Cadastre Committee's Action Plan included in Government's 2019-2023 Program of Activities approved by Government Decree of the Republic of Armenia N 1030-L dated 6 September 2018. In relation to the Pastures Information Management System, the cooperation with the envisaged Integrated Cadastre will facilitate the collection, processing and use of common spatial and cadastral data, eliminate duplicate and conflicting cadastral data with regard to lands ownerships and use, facilitate the process of creating backups of spatial data. In addition, under dues arrangements, it will potentially increase operational efficiency and reduce costs for the host institution and ensure accessibility to spatial data to other stakeholders as well as the public.
	Statistical Committee of the Republic of Armenia Agriculture Statistics Division Information Resources Management and Technologies Department
	Statistical Committee collects, processes, summarizes and publishes statistical data and maintains the databases on various themes and sectors of the economy. In particular, the Committee implements Agriculture Census and also maintains statistical data on land resources and agriculture, forestry and fishing, environment, irrigated lands, climate change including atmospheric precipitation data. <u>Agricultural Census 2014</u> In 2014, Armenia carried out the first Agricultural Census (to be conducted once in every ten years) covering agricultural food (crop and livestock products) producer's. The Census includes collection of information on the structure of agriculture, agricultural land, machinery, building stock, available resources (human, material) and their use at republican, regional (marz) and community levels. Article 5 on the subjects of the Agricultural Census and their obligations states the mandatory nature of census responses by natural and legal persons producing agricultural food. Of particular interest were the statistics related to the cattle numbers reported in an aggregated way on a marz level and the mechanisms of requesting disaggregated data on a community and settlement level in order to make the data usable for meaningful analysis.

2.2 Research and Academia

The research and academia stakeholder cluster is largely represented by the Armenian National Agrarian University, its affiliate labs and projects, including the International Center for Agribusiness Research and Education.

Table 2: Stakeholder perspectives: Research and Academia

	Armenian National Agrarian University
	The ANAU perspective on the proposed system is based on its established and rapidly evolving science and technology base, teaching and research activities and is therefore highly pragmatic pinpointing to the specific benefits that such a system could provide to both the university and the other stakeholders. The university prioritises the use of remote sensing technology and data for multispectral mapping of crops and other agricultural lands coupled with economic valuation of pastures, their biological productivity. In their view this could lead to the optimisation and improvement of resource use in economic terms, revision of cadastral valuation of land based on its current condition. The proposed system could contribute to the university's research activities, including on lands inventory, accessibility, livestock numbers and trends, erosion studies, environmental conservation. The *International Center for Agribusiness Research and Education Foundation*, established in 2005, which administers the Agribusiness Teaching Center (including GIS and Remote Sensing Certificate Program) and is one of the main knowledge capacity building organisations in agribusiness sector in Armenia can play an instrumental role in contributing its expertise and technical capabilities to the information system.

2.3 Local Communities

Meetings with the representatives (heads of communities, specialists, heads of agriculture and environmental protection departments) of communities covered 12 villages and towns in 3 marzes (Tavush, Syunik and Shirak). The sampling of communities was based on the differences in geography, climate, economic performance and diversity of agriculture sector.

Table 3: Stakeholder perspectives: Communities

	Communities
	The main and striking difference between the first two clusters of stakeholders and the local communities is the fact the latter is directly engaged with the issues, problems and challenges in pasture management and is very pragmatic and focused on the practical solutions. Though the community members were not sure on the direct benefits of the proposed system they nevertheless expressed willingness to engage as far as the system provides practical value for their day-to-day activities. Main preoccupations were uniform in all of the communities and dealt with:

- Soil erosion/degradation with perceptions on fast increase of non-usable lands
- Overgrazing, including large numbers of cattle brought it from within and outside communities, inappropriate practices (sheep vs cows grazing sequence). Lack of enforcement of proper gazing practices.
- The presence of unused fodder areas with limited access due to inadequate road network
- Climatic events and effects, including droughts, lack of precipitation, lack of snow cover, lack of accurate weather forecasting, extreme weather events, unpredictable patterns, especially precipitation
- Lack of infrastructure – water feeders, that in combination of the climatic trends aggravates the situations.
- Presence and fast spreading of invasive species that in some cases affect the health of the cattle. Poisoning plants and intoxication cases were reported too.
- Land inventory – not clear boundaries which is a source of confusion

Among the possible solutions, the community members discussed were:

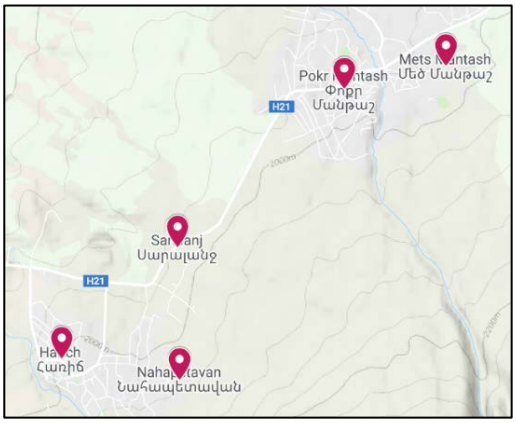
- Animal tracking to allow for monitoring grazing pressures and compliance to the set quotes (cattle head quantity vs allowed grazing pressure) and rotational plans
- Land restoration works over degraded fodder areas
- Availability of pasture keeper per settlement
- Increase the awareness level on good practices and norms
- Run predictions on increase of livestock to enable better planning
- Consider climate change proofing activities to mitigate against and adapt for the changes
- Improve the accuracy of land records and maps

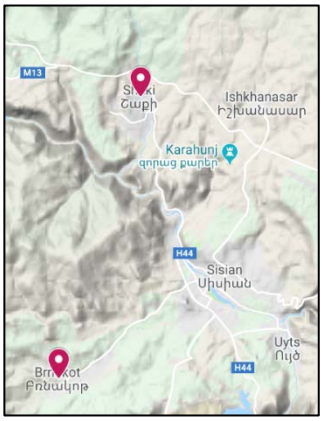
Overall, there is an acute understanding of the importance of balancing environmental – social – economic aspects of sustainable management of fodder areas management for solving critical issues in the communities such as unemployment and migration.

Visited communities

Sisian
- Shaki
- Brnakot

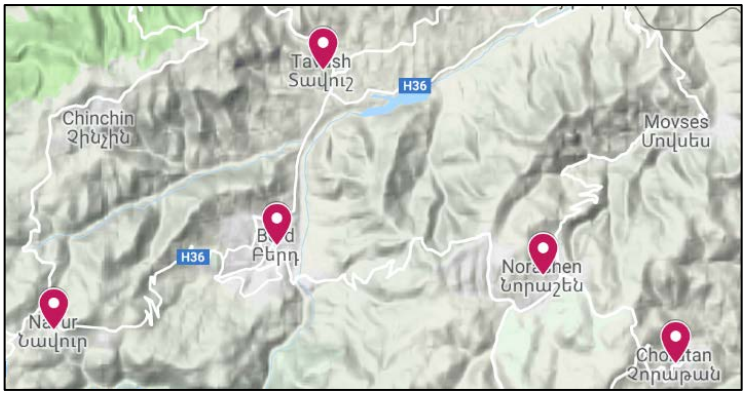
Saralanj
- Saralanj
- Mets Mantash
- Poqr. Mantash
- Haritch
- Nahapetavan





Berd

- Navur
- Norashen
- Choratan
- Tavush



2.4 Program Coordination Platform 5-th Workshop

“Program Coordination Platform for Sustainable Management of RA’s Natural Fodder Areas: Pastures and Grasslands” 5-th workshop took place on September 17, 2019.

It was dedicated to the a) presentation and discussion of the feasibility study on the possible structure of the pasture and grasslands information system and b) hosted the presentation of the preliminary conceptual demo version of the proposed system.

The workshop hosted around 40 participants from a wide range stakeholders and interested parties. It featured presentation on the feasibility study conducted by the consultant and system prototype developed by ZEBRIS and hosted via its Firemaps platform (firemaps.net), as well as discussions over the institutional and technical aspects of the proposed system. The consolidated feedback received during the workshop was used in the finalization of the concept and the roadmap of the system and the recommendations.

Consolidated feedback

The importance of such an information system or a database for the effective management of the sector and decision-making based on solid data is undisputed.

It was emphasized that the works on the information system for fodder areas should

start with the creation of database. This would allow enable, upon necessity, an integration with any other systems, considering the existing initiatives and projects, for example that of the Integrated Cadastre, the envisaged MoE Biodiversity Information System the data of which could be incorporated into or integrated with the proposed pasture database system. In addition, recently, an agreement was signed with the UN FAO Global Soil Partnership, which will develop soils information systems on a national scale.

The stakeholders stressed the importance of an ongoing inter-sectoral cooperation and continuous engagement of the interested parties within the framework of the development of the proposed information system.

It was also suggested, as a first step, to create the most needed data layers including accurate maps of the pastures and grasslands with lands quality and condition attributes.

Other feedback of technical nature voiced during the workshop:

- The frequency of data update in the system would depend on the type. The criteria for updating each dataset will be determined during the implementation of the proposed pilot.

- The system should prioritize the provision of pasture productivity information as this is the basis for determining the permitted pasture loads. It is also important to include meta information on the latest data updates. It is advisable to have information layers containing information on air temperature and sunshine duration over pasture areas.

- It was emphasized that land protection and anti-erosion measures are of national importance and from this point of view it is important to include in the system information on the opportunities and/or needs for improvement in a given pasture.

- Integration and interoperability of all existing systems need to be ensured in order for the data entry provider to enter the information once and through a single interface. In addition, it is important to establish protocol standards (standards) for data collection so that data can be uniformly collected.

- Data from the Real Estate Cadastre Committee of Armenia contains inaccuracies in both the land records of different communities and the operational or use types of the lands. In addition, there are inconsistencies with the combination of cadastral values for different land categories and their real quality, condition and productivity.

- It was stated that the goal would be to put a minimum burden on those responsible for data acquisition and input, which could be achieved through the use of satellite data processing and analysis automation tools.

- The issue of finalising the selection of the institution that could assume the responsibility for hosting and operating the proposed system was still open.

Among the potential uses of the system the participants mentioned also the monitoring of unused pastures and grasslands as well as indexing of pastures for easy identification and management. The system would also be useful in identifying and mapping the needs for infrastructure for cattle and herders especially in the highlands. It could help to automate the placement of infrastructure (water feeds, small houses for herders) based on certain parameters, volumes of grazing, cattle numbers, topographic relief and availability of water. Estimation of economics impacts of pastures on nearby communities was also mentioned as one of the by-products of the proposed system.

The minutes of the 5-th workshop were published on the web-site of the Ministry of Economy at https://mineconomy.am/news/1830 and Armenpress news agency web-site at https://armenpress.am/arm/news/988371.html.

2.5 Persona Types

The stakeholder analysis and clustering revealed the three main types of information system users, broadly defined as 1) the Government and public institutions in general, 2) Science and academia represented by educational institutions, non-for-profits and 3) Local communities' leadership.

2.5.1 Government

Figure 1: Persona card: Government

Areg – Civil Servant

Vital statistics

Areg is a middle-aged head of department that is part of a ministry overseeing agricultural sector in the country.

He manages a team of specialists who provide advice in their respective areas of expertise. He and his team are moderate users of computer hardware and productivity software and mobile apps.

They are usually very busy and with virtually no additional time allowance they could make for any extra commitments and tasks.

Goals and needs

Areg's main goals in relation to the field of agriculture refer to the contributing to the development of new and reforming of existing legislation, preparation strategies and elaboration of specific technical assistance programs and monitoring of existing ones. His department is expected to help the government and donor community to identify target areas for intervention. For this, David needs to improve in-house technical capacities of his team simultaneously building cooperation with the relevant stakeholders to supplement the gaps in knowledge and technology that he knows are inevitable.

Areg's motivations

Areg works in a public institution tasked with policy and decision making, elaboration of strategies, legislation and normative acts, programmers' monitoring and coordination. This gives him the privilege to see the bigger picture of the overall environment in which the sector operates. He sees the importance of science-policy nexus, the cross-cutting issues e.g. food and water security, social implications - migration and unemployment that the field of agriculture has impact on. However, while motivating, this responsibility also brings frustrations and challenges.

Areg's frustrations

State institutions are characterized with relatively slow inertia and large amount of administrative work which takes up considerable time. Lets add to this Areg's challenges and frustrations:

- Difficulties in coordinating multiple stakeholders across public, private, non-profit and international domains to make sure that the activities undertaken are well coordinated and are in line with the national strategies.
- Decisions and policies are ideally developed on the basis of evidence. Lack of credible and consistent data sometimes affects the effectiveness of his work
- Local challenges are many and with little progress – recovery programs for degraded soils, mitigation against the climatic events, new legislation and normative acts are slow to take off having significant impact on the industry.

Use case

Areg uses the knowledge and database to gain insight on the current state of affairs in the field of interest. The knowledge base contains information and data in various forms that he can use to support his department. Areg and his team are daily users of the system accessing complete range of available information:

- Reports, guidelines, scientific articles
- Static and interactive maps
- Raw data and statistics

They also make use of the functionality of the system such as spatial and multi-criteria analysis, measurements, mapping, data visualization tools.

He plays around with the toolkit trying to ask questions and various „what ifs" generating scenarios for the issues at hand. Importantly, he also uses the system to:

- Be informed about latest developments in the sector
- Keep in touch with the stakeholders engaged with the system and when required tap into their expertise, get advice whenever there is a lack of in-house expertise
- Contribute to the system by providing up-to-date information on government's side
- Making sure that the data is developed in line with the standards, methodologies and protocols to ensure the continued interoperability and compliance of the system.
- Use the data and system tools for evidence based decision making.

2.5.2 Science and Research

Figure 2: Persona card: Science, Research, Academia

Diana – the Scientist

Vital statistics

Diana is a young professional and a researcher affiliated to one of the leading educational institutions in the country. She is also engaged in teaching and mentorship of students and early stage researchers.

She is a moderate-to-advanced user of computer hardware and software and masters a few specialized applications incl. GIS, remote sensing, statistical and other analysis software.

She speaks comfortable level of technical English and has access to a vast body of scientific knowledge and practice. Diana is a quick learner and is open-minded when it comes sharing her skills.

Diana's goals and needs

Diana's main goals and needs lie in the realm of advancing scientific research and adapting it to day-to-day practices and operations in whichever field she works on. Being specialized in specific fields of expertise Diana can precisely formulate her wants and needs.

One of by-products of her research is the potential influence that the science and research could have on evidence-based policy-making.

Diana's motivations

Diana is largely self-motivated and spends considerable time and resources for personal development. Her motivation is regularly boosted by participation in specialized courses in her domain and occasional expert involvement in projects.

Diana's wide professional network is an additional source of motivation, feeding her genuine interest and willingness to engage in new initiatives as long as they serve well-defined purpose and are not superficial by nature.

Diana's frustrations

Diana is constantly frustrated with the lack of quality and consistent data over the subject matter of her interest. Science is based on data, her existing reality says that data:

- Exists but is scattered among various institutions, projects, and even individuals
- Is outdated and of little relevance
- Is hard to inventories and access
- Does not exist at all and there is little or no capacity to develop it.

She is also frustrated at the lack of opportunities for her students to get involved in thematic projects as interns and inadequate level of engagement of her institution with the ongoing projects and initiatives in the sector of interest.

Use case

Diana is daily user of the system. She taps into the vast repository of data that feeds her research activities.

As part of her research she is using the system for analysing economic values of land of different categories and usage types.

The results of her research can potentially and complimentarily be used by the government for adjusting cadastral valuation of land based on recent and science-based data and analytics.

Diana does so by combining soil and vegetation properties, nutritional values with the existing type and value allocation, usage patterns and current outputs, and projected optimal use in terms of economic efficiency and sustainability.

Being a researcher, Diana has the capacity to pool together a large variety of thematic data from different, though interconnected domains, such as climate, biodiversity, forests, water, agriculture, economics, statistics, infrastructure.

This combination of data and information is used to produce meaningful analytics and information products for decision-making and planning purposes.

She would also be happy get engaged with the system as one of distributed moderators since she understands the value and the long-term impact that such a system can have for the academia and research as a whole and agriculture and pasture management in particular.

2.5.3 Community

Figure 3: Persona card: Community

Hayk – Local community leader

Vital statistics

Hayk is a middle-aged leader of local community, who is hard at work handling a wide range of pressing administrative and operations issues in his village. He is chronically short of time, but is surrounded but a team of dedicated aids who facilitate the running of day-to-day life in the community.

He and his team are moderate users of computer hardware and software and can quickly grasp the benefits that the user-friendly and easy to use technology can bring as far as they directly relate to the problems faced by the community.

Hayk's goals and needs

Hayk's main goals in relation to pasture management can be summarized as:

- Increasing pasture productivity and identifying and accessing new areas
- Reduce livestock loss due to toxic plants
- Making efficient use of Management Plans
- Receive government support - law enforcement, legislative frameworks, degraded land restoration programs
- Handling and mitigating against climatic variabilities such as prolonged droughts and lack of precipitation.

Hayk's motivations

Hayk's understands that balancing the triangle of environmental, economic and social aspects will ultimately produce positive and long-term impacts on the community, including easing the unemployment and migration, increasing the agricultural output at the same time ensuring the sustainability of land use.

Hayk's frustrations

Hayk's frustrations are many and are mainly grounded in the problems associated with the lack of government support (legal frameworks and law enforcement) on one hand and the other the dwindling fodder resources in his community. The main challenge for Hayk is how to reconcile the various elements that the livestock farming and keeping depends on, such as:

- Persistent overgrazing and lack of control over the number of livestock. His frustrations extend to the unregulated grazing practices with animal stocks crossing community boundaries
- Maintenance of nutritional values of pastures and fodder areas
- Scarcity of water sources
- Climatic events that affect agricultural crop yield and pastures productivity (droughts, precipitation). While this factor is out of control – the lack of mitigation measures (such as water retention and distribution) represents a major frustration.
- The degradation of pastures that takes its toll on the productivity with little or no recovery programs.

Use case

Hayk uses the knowledge and data base to complement the information already available at hand (management plans, local and traditional knowledge).

He accesses detailed and high-resolution maps and satellite imagery drawn from multiple sources to aid him in day to day operations and for decision making and planning.

Apart from simply browsing maps and imagery Hayk is getting proficient with maps overlay, visualization and analysis - his favorite tools.

Comparing land use maps, near-real time vegetation health indices, soil degradation maps and livestock allocation patterns he can learn more about the correlations between them. These exercises go hand in hand with following the Management Plans.
In particular they add value to controlling grazing pressures through rotational plans and maintaining nutritional values of fodder areas.

Additionally, with the help of land use, vegetation index maps, and road networks Hayk tries to organize access to remote pastures that are of high value, yet hardly accessible.

Combining science with economics he now has more compelling evidence to work with the government and international donors to pinpoint specific target areas for intervention.

He is also happy to contribute back to the knowledge base by regularly uploading field data into the system, thus increasing its value to other stakeholders - the government and academia.

3. Summary of situation analysis: enabling environment, capacities, legislation

The economic importance of natural fodder areas, which comprise a significant proportion of the total territory of RA and of the agricultural lands cannot be underestimated. The optimal use of the pastures and grasslands for their primary function of the livestock keeping and also as a resource for ecosystem services can only be achieved through rational and sustainable use of the land and supporting infrastructure which requires institutional and regulatory alignment, efficient management of human, technical, financial resources, and coordination of effort at all levels from the Ministry of Economy to the local communities, academia, private and non-profit sectors.

The analysis reviews the situation with the enabling environment through the prism of the main factors that potentially affect the development and operation of an information system for pastures and grasslands.

The institutional, economic and technical aspects for the deployment and operation of the system represent a complex web of environments interlinking the key, largely representing the public sector, state stakeholders.

The main factors to assess the feasibility for a successful design and deployment of a system as applied to the key components of the enabling environment are:

- Institutional clarity and readiness
- Data environment
- Knowledge and skills capacity
- Legal environment

A. Level of institutional clarity and readiness

This factor significantly affects the feasibility of deploying a system since clear mandates, inter and intra institutional information exchange and use protocols, responsibility matrices lay at the foundation of an information system design and subsequent operation.

The current situation with the ongoing reforms and institutional changes within the key stakeholder institutions such as Ministry of Economy and the Ministry of Territorial Administration and Infrastructure is characterised with uncertainty, lack of clarity with the mandates, fluid matrix of functions and responsibilities within their respective departments, high levels of staff rotation and unclear protocols for information sharing and exchange.

This fluidity of otherwise and traditionally rigid structures represent a clear constraint and a potential risk for the design of complex, inter and intra institutional information systems with management and transactional functions, information and data exchange protocols, multi-user and multi-level environment.

On the other hand, the positive economic trends and capacity development interventions prop up the demand side and justify the need for having such a system, which could act as a contributing technological factor for the sector, given the existing government support, investments and promotion, contributions of the international assistance projects and interventions that are oftentimes act as game changer and catalyst for positive developments.

With the persistent issues with the less than desired conditions of natural pastures and

grasslands, that are being deteriorated due to insufficient management practices the issue of prioritization of rational and sustainable management of natural fodder areas is acknowledged by all parties.

Existing developments, projects and initiatives, notably the large scale interventions like the Second Community Agricultural Resource Management and Competitiveness Project for Armenia which is set to improve productivity and sustainability of pasture and livestock systems in up to 100 communities in eight regions of Armenia, reinforce the need for coordinated approaches towards data and information sharing among stakeholders, having a positive effect on the institutional enabling environment by providing, in an organized and integrated manner, critical, timely and accurate data for decision and policy making.

At times of institutional uncertainty the facilitating role of the "Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands" Platform and its bridging activities are instrumental for the preserving the dynamics of the sectors and ensuring the continued cooperation between the parties. Recent initiatives by the platform include developing a Concept paper for the sustainable management of natural fodder areas in Armenia.

B. Data environment

This factor covers macro, meso and micro scales, from the national strategy for the use of technology and data as a supporting pillar of the economy and state level interventions and projects (integrated cadaster, standards, etc) to technical capabilities and capacities of the main actors (stakeholder institutions) and at micro-level the technical capacities and availability of technology for individual actors (local communities, experts).

Considerable amount of feedback centered upon either the complete absence critical data and maps or the persisting lack of quality with the existing data citing among other parameters the currency, accuracy, coverage, usability of datasets. Mismatching of data between the existing situation on the ground and cadastral records for pasture boundaries was reported.

Where data exists it is most of the time scattered among different institutions with varying degree of quality and unclear versioning and access conditions.

The situation with other data related issues is no less critical and includes lack of good practices and protocols for data storage and archival, lack of capacities with acquisition of real or near-real time data, and regular data updates, lack of trust in the statistical data.

The situation with the lack and low quality of data coincides with the most urgent and data intensive problem-solving needs such as identifying reserves and underused areas, priority pastures that have high productivity, economic potential or are at risk of degradation if no action is taken, identification of overgrazing, pasture monitoring data.

A clear positive development is the concept of Integrated Cadastre, which has been developed in compliance with Real Estate Cadastre Committee's Action Plan included in Government's 2019-2023 Program of Activities approved by Government Decree of the Republic of Armenia N 1030-L dated 6 September 2018. However, it is expected that the whole process of introduction of Integrated Cadastre will take 5 years, which lies far beyond the desirable timeframe for the development of the pasture and grasslands information system.

C. Knowledge and skills capacity

The long-term availability of educated and skilled workforce that could uptake the task of implementation of the system, which, is in essence requires a multidisciplinary and well-coordinated effort for successful operation. The current situation with the human resources is characterized by *fragmentation of the key skillsets* among stakeholder institutions on one hand and *high levels of staff rotation* on the other. The absence of institutional knowledge retention practices, especially in public institutions further exacerbates the problem.

The current situation with fragmentation knowledge and skills and fluidity of human resources creates a high degree of uncertainty and low level long-term commitment. This reality calls for three-faceted intervention approach of a) Capacity building for the key missing skills, b) Skills complementarity through cooperative work and partnership and c) development of knowledge capital retention and institutionalization mechanisms. All these approaches represent workable solutions that could be implemented within the framework of an information system.

D. Legal environment

The legal environment is comprised of a set of normative and legal acts that cover multiple domains, including but not limited to the legal frameworks for information technology, electronic communication, cartographic materials and cadastral records, land management, flora and fauna.

The results of the interviews with the stakeholders revealed that the most common issues are generally that of the lack law enforcement and specifically, in relation to the information system, lack of mechanisms and protocols for inter-institutional data exchange and unclear mandates for handling intra-institutional information flows as well as overlapping and unclear institutional responsibilities.

It should be noted that The Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands, as one of its objectives, takes up an active task of submitting proposals to stakeholder agencies on amending or changing legislative and administrative acts, laws, decrees where there are gaps or shortcomings.

Legal base

The Decrees of RA Government of October 28, 2010, N 1477-N and April 14, 2011, N 389-N on Setting the order of utilization of pastures and grasslands in the Republic of Armenia, providee a comprehensive coverage of the field by setting the conditions of management and efficient use of pastures and grasslands on state-owned lands. The decree sets up objectives and tasks that deal with protection and sustainable and efficient use of natural fodder areas, creation of favourable conditions for restoration and improvement of productivity, prevention of deterioration of qualitative characteristics of pastures and grasslands. The decree also stipulates the use of plans for pasture use, which include variables like the number of animals and productivity levels of pasture, set (based on the conditions for each year) start and end dates for the seasons. Additional norms and criteria for efficient use of pastures are also included in the decree.

Overall, and apart the specific subject related legislation, the broader scope of the normative and legal acts related to the creation and introduction of system, considering the rich diversity of the data types and sources, includes the following codes and laws:

- Land Code of the Republic of Armenia,

- Forest Code of the Republic of Armenia,
- Water Code of the Republic of Armenia,
- Code of the Republic of Armenia about subsoil.

- Law of the Republic of Armenia on Specially Protected Nature Areas,
- Law of the Republic of Armenia on Flora,
- Law of the Republic of Armenia on State Registration of Property Rights,
- Law of the Republic of Armenia on Geodesy and Cartography,
- Law of the Republic of Armenia on Fauna,

Additionally, the following Government Decrees of the Republic of Armenia may bear relevance:

- RA Government Decree N 133-Ն dated 7 February 2008 on "Establishing Forest State Cadastre Management Procedure and State Registration of Forests and Data Provision".
- RA Government Decree N259-Ն dated 20 March 2008 on "Establishing Specially Protected Nature Areas State Cadastre Management Procedure",
- Decree N140-Ն of the Minister of Nature Protection of the Republic of Armenia dated 13 July 2009 on "Approval of Methodological Guidelines for Management of Flora State Cadastre",
- RA Government Protocol Decree N33 dated 13 August 2009 on "Approval of 2010-2015 for Flora State Cadastre Development Integrated Project",
- RA Government Decree N831-Ն dated 23 July 2009 on "Approval of Data Provision Procedure for Flora State Cadastre",
- RA Government Decree N197-Ն dated 20 January 2005 on "Approval of the Concept on Creation and Management of Geoinformation System of the Republic of Armenia",
- RA Government Decree N1441-Ն dated 13 November 2008 on "Approval of Fauna State Cadastre Management Procedure",
- RA Government Decree N832-Ն dated 23 July 2009 on "Approval of Fauna State Cadastre Data Provision Procedure",
- RA Government Decree N145-Ն dated 16 July 2009 on "Approval of Methodological Guidelines for Fauna State Cadastre Management ",

Additional considerations should be given to:

- Information security arrangements in compliance with internationally recognized standards, particularly the ISO 27000 series, although optional (and entailing certification costs) and relevant only for later phases of the system development (should the beneficiaries wish to pursue a full scale management information system).
- The role of the Ministry of Territorial Administration and Infrastructure, as an the authorized body in the implementation of community cadastral functions,
- The role of the Ministry of Environment maintains state cadastres of forest (N 133-N, 2008), water resources (No. 68-N, 2017), specially protected nature areas, (N 259-N, 2008) waste (N 144-N, 2007), flora (N1440-N, 2008), fauna (N1441-N, 2008).
- The role of the Ministry of High-Tech Industry as a central body of executive authority that develops and implements the Government's policy in the fields of communication, information, information technology and information security.

The design, development and running of an information system for data collection, storage, processing, analysis and visualisation within the host institution does not require a specific regulatory base, and there are no legal, regulatory restrictions that could affect its development

and operation, except for ensuring standards, and data security and privacy considerations and adhering to data exchange protocols that exist between participating departments and institutions.

Capacity assessment

Overall, the discussions with the state institutions and affiliated bodies revealed interest and motivation for the proposed system primarily based on the practical need for data and evidence for policy and decision making.

At the same time there is a noticeable lack of technical capabilities and thematic and scientific expertise within the institutions in public sector related to data management and analysis (except for Real Estate Cadastre Committee's and ANAU's GIS/IT capacities).

The capacity assessment focuses on the Ministry of Economy's Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use, which is poised as the system's host institutions, the Armenian National Agrarian University, which has the potential to provide are specific expertise and local communities.

Table 4: Capacity assessment matrix

	Institution	*Human Resource capacity*	*Technical capacity*
	Ministry of Economy, Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use	Low level capacity with specialised knowledge and skills (IT, GIS, data management). Lack of dedicated technical staffing.	Low capacity in dedicated and high-power computer hardware and specialised software.
	Armenian National Agrarian University	Adequate to high level of capacity with specialised knowledge and skills in agriculture and related fields. Adequate to high level of expertise in technology (IT, GIS, data management).	Adequate to high level capacity with regard to specialist equipment and software, computing power, server capacities.
	Communities Ministry of Territorial Administration and Infrastructure / Department of Local Self – Government Policy and its Division of management of Community Information Flows	Adequate to high level of capacity and expertise through the engagement of specialised services for operation and maintenance of MMIS system. However, the reliance on external supplier represents continuity risks.	Adequate level of capacity and expertise through the use of MMIS infrastructure coupled with non-demanding requirements in terms of proposed pasture information system use (incl. mobile app.)
	Real Estate Cadastre Committee of Armenia represented by the Geodesy and Cartography Department. ** Viewed as a contributing agent, rather than user.*	High level of human resource capacity with specialised knowledge and skills (IT, GIS, data management).	High technical capacity in terms of dedicated and high-processing power computer hardware and specialised software.

4. Pasture and Grasslands Information System

4.1 The concept

The overall concept of the proposed system reflects the existing reality in terms of institutional setups, data availability, and technical, financial and human resource capacities among the key stakeholders that are proposed as the main carriers of the system.

The concept addresses the main gaps and offers to take them up as opportunities to make tangible operational improvements in the host organization over the near-and-mid term timescale and by addressing the immediate concerns.

Table 5: Gaps and Opportunities

Gaps and issues	Opportunities
Lack of quality, and at times complete absence of nation-wide data specific to pasture management practices, with the exception of specific cases where there were project interventions, scattered nature of the data and information.	Opportunity to create a high-value product with organised data at its core, complete with data management protocols, customised access for stakeholders.
Lack of the competences in using digital data analysis and integration tools that would support evidence-based decision and policymaking.	Opportunity for creating a standardised data processing and analysis toolkit as part of the information system.
Lack of all-encompassing in-house capacity within a single institution to support the development and operation of the information system.	• Opportunity to develop mutually beneficial cooperation model whereas each key stakeholder assumes responsibilities within their core competencies. • Opportunity to offer targeted capacity building interventions for specialisation • Opportunity to mitigate the risks through distribution of tasks.
Existing and planned initiatives and projects that could overlap with the information system development and operations and duplicate some or most of the envisaged functionality and data. Examples include “Agriculture Policy Monitoring and Evaluation Capacity Building Project” planned by the WB, Integrated Cadastre by the State Cadastre.	Opportunity for cooperation and alignment of timescales, concepts and technology – aiming to build a system that is not isolated but is rather interoperable, with a potential to be seamlessly integrated with similar platforms.

The feasibility of developing and sustainably operating an information system therefore rests on the pillars of addressing current and most urgent needs of the key stakeholders at the same time filling the gaps that act as impediments to the efficiency of public institutions, especially in the sphere of evidence-based decision and policy making.

- Is **realistic** in terms of timescales and relevancy – a system that would start serving the purpose in the near-term
- Addresses **immediate needs** of the key stakeholders and can serve its purpose being only few months into development
- **Simplicity** where possible, one of the key factors for system adoption, usage and sustainable operations over long-term. Complexities will be added later.
- **Modular** design – following the concept of Lego building blocks
- **Multi-phase development** with the initial phase producing the data foundation for the system that can be used by the stakeholders immediately, before advanced, including information management and transactional, functionality is added
- **Distributed moderators** of the system – based on a wider cooperation mechanism among the key stakeholders, data suppliers and users
- **Spill-over effects** – ability to incorporate data and information from various domains (biodiversity, wider agriculture, community management, land management) that will add to the value of the system
- **Integration potential** – with parallel projects and initiatives it is vital that the base of the system, comprising of data, quality standards and protocols, and other information resources is fully interoperable and can swiftly integrate with
- **Innovation and automation** – the system should host at least some of the critical innovation and automation tools amongst its functionality. Examples include Soils Sensitivity calculations and on-the-fly generation of vegetative indices and predefined reports for decision-makers.
- **From Information system to Management Information System** – clear transitional strategy over the long-term. Although it much depends on the progress with legislative and normative base in the public domain, the vision for a fully functional MIS should be considered as a desired future scenario.

4.2 Pathways

The possible pathways though at this stage presented separately, serve the cohesive vision of the system by being separated on a temporal scale with first focusing on the so-called data-centric approach, with gradual transitioning to MIS approach. The proposed concept concentrates efforts on creating knowledge and digital data repository and toolkits in an open and interchangeable format with distributed access and editing rights.

Table 6: Pathway: from data-centric to MIS-centric

Data-centric (years 1-2) ➔	**MIS-centric (years 3-5)**
Knowledge, information and data repository. Database platform based on industry standard open-source solutions.	Rich functionality that fully utilises the available data
Data standards, quality control, interoperability.	Analytics and information products have high credibility due to the quality control mechanisms put in place from the very beginning
Centralised storage with custom access rights, data entry through PC terminals with possibility of remote entry for data providers	The added functionality is accessed by the stakeholders from various locations
Key functionality for addressing immediate needs as listed in Data and feature list of the Interactive visualisation and analytics part of the section 4.3.	Extended functionality and support to the management (transactional) functions, in line with legislative, normative reforms, established protocols, stability of institutions
Capacity building for key stakeholders – expertise, computer HW and SW	Continues improvement of capacities.
Advantages of the approach	
• Supports the mission critical and data intensive operations by the state institutions and local communities (for example, elaboration of management plans, support to legislative and normative reforms and improvements as a one-stop-shop resources for pasture related information) as well as provide a wide range of information and data to science and research institutions and non-profits. • Ensures data versioning, considering the likelihood of regular updates and corrections • Low risk of heading to a wrong direction as this pathway focuses first on data creation and key analysis tools already found in mainstream open-source software packages rather than the development of a new management system in the absence of legislative and normative clarity • High capacity for integration into larger systems due to interoperability • Fully complies with the idea of multi-phase development • Can be decentralised (with centralised backups) to enable efficient administration • Shared moderation and responsibilities – avoiding placing a burden on a single organisation • Simplicity at the beginning with far less risks involved in case of sudden changes in policies and priorities – data and information have an established value • Allows for experimentation and adjustment, while watching the timelines of and progress with similar projects (aiming to integrate at the end of the pilot project lifecycle OR continue operating as a standalone system – lowers risk of shutdown if it turns out that there is still no wider agriculture related system to become part of). Mitigates the risks of ending up as a standalone and isolated system while larger systems are anticipated.	

The inception phase of the system development assumes a creation of the vanguard force comprised of the key stakeholders and users that would share the responsibility for the planned system as per the available existing institutional capacities as well as the anticipated uses of the system:

- **Ministry of Economy** – Evidence-based policy and decision making, with in-house capacities to support the critical functions of the ministry as a whole and the relevant departments;
- **Armenian National Agrarian University** – Science and research, analytics, creation of new information products;
- **Pasture Platform** – taskforce that would specifically coordinate the activity in close coordination with analogue initiatives and projects processes within the state institutions (Integrated cadastre, Agriculture Policy Monitoring and Evaluation Capacity Building Project)
- **Ministry of Territorial Administration and Infrastructure / Local communities** – Institutional support, potential interfacing with MMIS, field data supply by the communities and auxiliary use of the system for Management Plan compliance (monitoring, forecasting)
- **Ministry of Environment** – given its mandate of oversight (incl. over land use, land protection, biodiversity, forests) and environmental monitoring and as a co-beneficiary of the information and analytical products produced by the project.
- Other stakeholders would assume supportive roles (data suppliers and users)

Various combinations for participation may exist depending on the mandates, functions and available resources.

This vision also ticks the boxes with the main structural features that were included in the initial concept of the system prior to the feasibility study:

Table 7: Base criteria and requirements

✓	A tool for sustainable pasture and grassland monitoring at national level,
✓	A tool for sustainable pasture and grassland management and decision making,
✓	Possibility to show trends for certain pasture and grassland areas conditions, e.g. to provide options for an early warning on pasture degradation,
✓	Serve as an information management tool for decision makers to help reduce grazing in forests and thus support sustainable forest management,
✓	Help communities to maintain pasture productivity,
✓	Should have a map component with all relevant spatial information already uploaded to the system. It should also contain freely available satellite services that support pasture management (Sentinel2, Landsat8, MODIS, METEOSAT, etc.)
✓	Should be easy to use and user friendly,
✓	Allow and support the upload of information from the field into the system (Optional: have mobile app versions)
✓	Function as a management tool for pasture fees by municipalities (income, quality, carrying capacity)
✓	Existing tools, information systems and documentation should be considered
✓	Should be designed using open-source software.

4.3 Data and feature list

The following is the base data and functionality list for the data-centric information systems under the assumption that it interfaces with the open-source GIS environment (for example QGIS), and can be coupled with a mobile application for field data collection. The list is not all-inclusive and may be revised and complemented as required depending on the finalised needs of the systems users for the piloting stage. It is to be noted that the basic functionality such as area and distance calculators buffering and similar spatial tools are by default available in standard GIS software packages and do not need to be developed separately.

Table 8: Data layers and feature list

	Data layers, sources and features
	Base maps, terrain and infrastructure
	Administrative boundaries at national to settlement levels
	Road network
	Irrigation network
	Water bodies, reservoirs, lakes
	Digital Elevation Models, aspect, contour lines
	Satellite imagery (Sentinels and Landsat) link to the data providers with a possibility to download and make accessible in an offline mode
	Administrative maps, road networks, water bodies may equally be sourced from the Cadastre Committee or the free and open sources such as OpenStreetMap platform, the latter being of sufficient quality and coverage for the initiation stage of the system. Digital Elevation Models and the satellite imagery of acceptable resolution (down to 10m/pixel) are freely available from online data distribution platforms of USGS and the Copernicus Programme of the EU.
	Climatic, environment
	Climate zones
	Precipitation, temperature, winds, humidity
	Solar days
	Soil types, nutrients
	Vegetation maps
	Biodiversity maps
	Forest cover
	Landcover maps
	For thematic maps it is recommended to enquire with the State Committee of the Real Estate Cadastre which maintains and publishes the National Atlas (Հայաստանի Ազգային Ատլաս). Other sources for land cover maps may include ESA Land Cover CCI (The CCI-LC project delivers consistent global Land Cover maps at 300 m spatial resolution on an annual basis from 1992 to 2015) while higher resolution land cover maps can be developed by the third-party supplier and/or the beneficiary team at the initiation stage of the project.
	Interactive visualisation and analytics
	NDVI, Drought, Moisture, Land degradation, other regularly updated indices
	Soils Sensitivity maps, manually or automatically generated at regular intervals
	Forest fires risk detection maps rendered through API from third-parties
	Meteorological and weather records
	Animal livestock numbers regularly updated (through disaggregated statistics)

	Road accessibility map (road condition mapping)
	Land use mapping
	Most visualisation and analytics features/functionalities are readily available in both commercial and open source GIS and remotely sensed image processing software. *Meteorological records can be sourced from the national Hydromet service.* *It is recommended that the beneficiary institution links up with the EU's Copernicus Programme and similar platforms that supply real-time forest fire risk mapping information as well as explores the local capacities such as the National Forest Management Information System.*
	Knowledge base
	Thematic reports, guidelines, knowledge repository
	Disaggregated statistics on key agricultural data *Sourced in cooperation with the Statistical Committee and the local authorities tasked with the collection of the original disaggregated data.*
	Management plans data (may include both spatial and attribute datasets)

Land cover and land use mapping data within the system is of particular importance since it would allow for Identification of the existing situation on the ground, land condition, degradation levels and historical land use patterns and creation of an archival database of RS imagery.

While most data layers will have national coverage, it is recommended to select at least two sample areas with varying agro-climatic conditions for an in-depth field data collection and ground truthing that would allow to establish data rich and scientifically sound baselines for analysis and scaling up and extrapolation of results.

Historical land use mapping (optional and of secondary importance) could be implemented using Sentinel 2 and Landsat 8 imagery (Landsat 5 and 7 for historical land use patterns starting from 1998, 20 year period). While standard land cover classification algorithms (supervised and unsupervised classification algorithms found in remote sensing imagery processing software applications in conjunction with ground control data from the field) can be used, it is advised to coordinate the methodology with the relevant stakeholders to ensure consistency, compatibility and scientific rigour of the resulting land cover map. Such coordination between the expert teams would also ensure the consistency of the land cover types (classes) with the national standards thus increasing its usability across the partner network.

Overall, the data housed in the system and the functionality and analytical tools available to the users through interfacing applications (such as for example GIS software) at the completion of the initial phase should:

- Facilitate information and data sharing, reporting
- Provide for change monitoring and trends detection of natural fodder areas over time
- Allow for monitoring and control of pastures and grasslands
- Improve the efficiency of pasture management practices, as well as development of management plans
- Provide decision makers with real or near-real time information

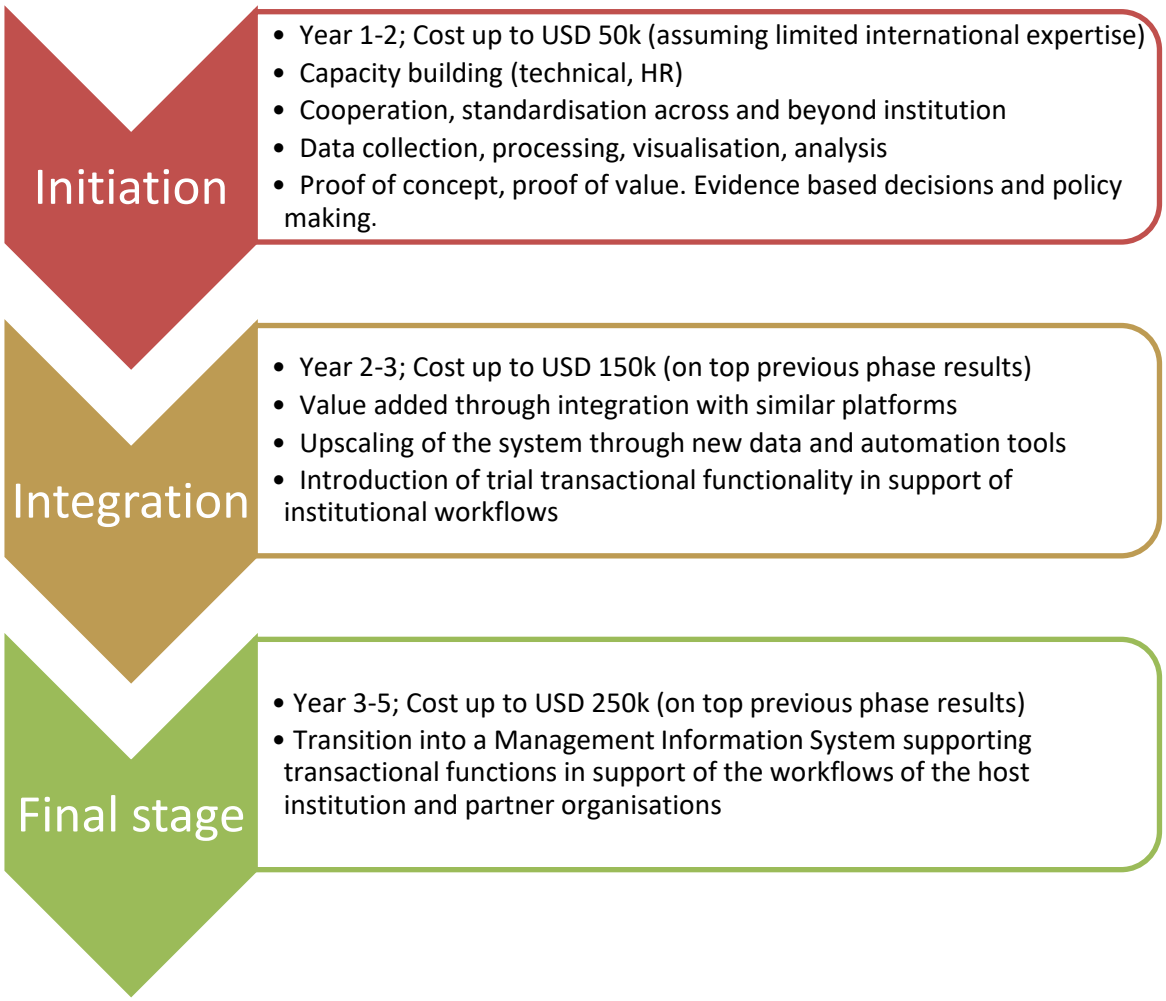
4.4 Roadmap and Timeframe

The roadmap for information system implementation from inception to the fully transactional and advanced information system takes form of a three-tier process diagram starting with the initiation phase, moving towards Integration phase and developing into a management

information system. After the implementation of the initiation phase, the system may continue running as a largely standalone system, or a decision may be made to extend it and integrate it with other similar systems, for example with or into a larger scale agriculture or other information systems, such as:

- Municipal Management Information System
- National Forest Management Information System
- Integrated Cadastre
- Agriculture Policy Monitoring and Evaluation Capacity Building project

At any stage, the beneficiary(ies) may decide to halt the process should the system at that particular stage suffice the needs of the host institution with little or no added benefit in case of further development.



The so-called Zero option may be a viable alternative too, should the stakeholders choose not to proceed with the development of the proposed system.

Table 9: Timeframe for Initiation phase

	Activity / Months	1	2	3	4	5	6	7	8	9	10	11	12
	Project inception, definition of requirements												
	Procurement of HW, SW; hiring of experts												
	Information system setup, structure, protocols												
	Training: GIS/RS/ICT4D for managers												
	Training: GIS basic-to-advanced levels												
	Training: Image processing, basic-to-advanced												
	Training: Data management and DB administration												
	Interim stakeholder meeting and project review												
	Data collection, processing, archival, mapping												
	Fieldwork												
	Development of automation tools/plug-ins												
	Mobile app development												
	Introduction of the mobile to local communities												
	System use for creation of value added products												
	Lessons learned and next phase decision												

It is assumed the capacity building and the training sessions will be conducted in on-the-job mode and will be held parallel to the information product and maps development enabling the trainees to work on the very datasets that the system will be housing.

If deemed appropriate, it may be an efficient use of time and resources to acquire a one-off set of mission critical analytical datasets (processed satellite imagery and derived products / thematic maps) from a third-party supplier, however with clear indication of the methods to ensure the replication of the work in local settings at the beneficiary's institution.

4.5 Risk assessment and mitigation

The complexities and interdependences associated with the design, development and operation of an information system come with a set of associated risks at different thematic levels and temporal scales.

Most of these risks are present throughout the near-term period and can be mitigated applying preventive measures built in to the concept of the information system. The risks are grouped into four main categories:

a) **Institutional** – primarily dealing with high rates of staff rotation within the public agencies and ministries in particular coupled with ongoing institutional changes that involve transfer of staff, functions and responsibilities between departments, with the information system potentially a risk of finding itself in interdepartmental limbo; Inadequate cooperation and exchange of information between the departments and divisions could also be an impediment for effective building and utilisation of the system;

b) **Inter-institutional** – lack of cooperation and an established thematic information sharing arrangements, especially with regard to the ongoing and upcoming initiatives and projects that could create an overlap of activities and duplication of efforts. Additional risks involve potential disagreements over the ownership of the proposed information system.

c) **Financial** – perhaps financial risks pose lesser challenge to the implementation of the project since these can technically be addressed for the initial stages of system building and mitigated through a number of measures as detailed in the Risk Mitigation table below.

d) **Technical** – technical risks include the lack of technical expertise by the host institution as related to information systems, GIS and remote sensing, data management in general. Low capacity in terms of hardware and software is also present, though it is of a lesser prominence.

Table 10: Risk assessment

	Risks	*Near-term*	*Mid-term*	*Long-term*
	Institutional			
	High rates of staff rotation	**X**	**X**	**X**
	Inadequate inter-departmental cooperation	**X**		
	Ongoing institutional changes	**X**	**X**	**X**
	Inter-institutional			
	Lack of cooperation	**X**		
	System management ownership	**X**		
	Financial			
	Inadequate startup funding allocation	**X**		
	Ongoing operational and maintenance costs		**X**	**X**
	Technical			
	Low technical expertise capacity	**X**		
	Low capacities in terms of equipment	**X**		

Table 11: Risk mitigation

	Risk	Mitigation measure
	Institutional	
	High rates of staff rotation	Ensure appropriate responsibility matrix with the host institution
	Inadequate inter-departmental cooperation	Establish an informal protocol of information and data exchange between the relevant departments within the institution through designated focal points.
	Ongoing institutional changes	Ensure that the information system operations and maintenance are insured from the possible institutional changes through corresponding operational and management protocols and agreements between the engaged parties.
	Inter-institutional	
	Lack of cooperation	Establish an informal protocol of information and data exchange between the relevant institutions through designated focal points.
	System management ownership	Universally agree that the system design, development and operations within the pilot stage are under the ownership of the proposed host institution with appropriate access and usage rights to all of the relevant stakeholders. Finalise the ownership after the completion of the pilot project when more information is available over its utility, operational specifics, lessons learned.
	Financial	
	Inadequate pilot funding allocation	Measured and target funds allocation through the EcoServe programme for the implementation of the system at pilot stage.
	Ongoing operational and maintenance costs	Beyond the pilot stage, this risk is mitigated through distribution of tasks through the key partner institutions that would uptake certain functions of the system appropriate to their expertise, experience and technical and financial capacities.
	Technical	
	Low technical expertise capacity	This risk is mitigated by providing the host institution staff with custom training on the key aspects of the system upkeeping, including advanced training on GIS and remote sensing technologies. Certain technical aspects such as programming of automation tools are outsourced to an external supplier.
	Low capacities in terms of equipment	The base equipment for the pilot implementation is supplied through the financial assistance.

5. Conclusions and recommendations

The feasibility study revealed the overwhelming support for the proposed system within the three main clusters of engaged stakeholders. While generally concluding on a positive note the study also revealed the institutional, technical and legislative constrains that would likely hamper the development and successful operation of the full-fledged system within the existing enabling environment. However, there is a potential to create the basic, data-centric information system that would form the backbone of the future system that would include transactional and analytical functionality in support of the management functions of the key stakeholders.

The study showed that for practical (achieving tangible results within the shortest time period) reasons it is necessary to differentiate between the immediate needs of the key stakeholders in the near-term that could create analytical products of high value to satisfy the most current and urgent requirements and those system components that are more specific to the long-term vision of the system.

Thus, the recommendations center on the near-term period and address the issues that may represent the primary building blocks of the proposed data-centric system. It is assumed, that for the pilot project scope, the *Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use* of the Ministry of Economy, will take the function of a host institution to uptake the leading role in the implementation and primary use of the proposed system.

Recommendations

- It is recommended, as an initial step, to focus on the development of a basic data-centric information system coupled with targeted technical capacity building of the host institution;

- In view of the findings of the study and the needs expressed by the proposed system host institution, it is recommended that the EcoServe programme provides technical assistance to the *Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use* of the Ministry of Economy as per the following components:

    - Capacity building: custom and targeted training in Geographical Information Systems, Remote Sensing and image processing at management and technical expert levels to allow the department to independently create analytical products with publicly available spatial and non-spatial datasets, learn data management techniques;

      Part of the capacity building should be the development of “Mainstreaming of Earth Observations” guidelines on geospatial concepts including Earth Observation, remote sensing, Geographic Information Systems to improve the understanding of these concepts among the key stakeholders. The guidelines should include information on the deployment of EO and GIS in projects of relevance, guidance for department heads and project managers to understand geospatial data sets, data products, platforms and tools that are relevant to functions of their units.

- Equipment: support the department with acquisition of server and computer hardware capable of high-speed processing of large volume satellite imagery datasets as well as data archival and backup storage external hard drives;

- Software licenses and subscription fees: support the department with the purchase of essential, industry standard ArcGIS software (to complement free open-source QGIS packages) and subscription to Sentinel Hub EO browser tool for on-demand generation of analytical products (such as vegetation indices).

- To facilitate the cooperation between the department and the wider circle of key stakeholders to enable efficient data collection, use and sharing of results with engaged parties; to receive continuous feedback that would form the basis for updating the vision of the information system beyond the proposed 12-month pilot implementation period.

- To promote innovation and engagement, and to contribute to the implementation of the proposed project, it is suggested that the EcoServe programme assists the MoE in organizing an idea and solutions generation exercise in the form of a Hackathon. The hackathon could address the existing problems by generating nonconventional approaches and methods through engagement of a wide range of multidisciplinary expertise from stakeholders and the wider public.

Recommendations to the Ministry of Economy
Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use

Given the role of the department in overseeing the use of pastures and grasslands as parts of the agricultural resource base and the development of cooperation between interested parties – it is recommended that the Division of Agricultural Resource Use takes up the role of the host for the pilot implementation of the proposed data-centric system.

- Establish regular communication with the key stakeholders as identified in Table 1 and in particular with the Ministry of Territorial Administration and Infrastructure, the Real Estate Cadaster Committee of Armenia (standards, basemaps, thematic maps), the Ministry of High-Tech Industry (to ensure adherence to the national strategy for the development and standardization of information and communication technology to which, in a global sense the proposed system belongs).

- It is recommended that the department identifies and actively tracks the existing projects and initiatives as well as those that are in the pipeline that may overlap with the proposed system both in terms of data and functionality. These include the developments with the “Agriculture Policy Monitoring and Evaluation Capacity Building Project” planned by the WB, Integrated Cadastre system by the Real Estate Cadaster Committee, the Municipal Management Information System curated by the Ministry of Territorial Administration and Infrastructure.

- To finalize the list of the immediate and mid-term tasks (on pasture and grasslands management and monitoring) that the department of Agricultural Programs Development, Resource Use and Cooperation Development is facing with the and needs technical assistance. This list will serve as the basis for preparation of capacity building intervention by the EcoServe programme.

- Finalize the overall list of required data and functionality and prioritize the three most needed data layers the availability of which could address the critical needs of the

department.

- Liaise with the Agriculture Statistics Division of the Statistical Committee of the RA to discuss the possibility of receiving, on a regular basis the disaggregated statistical information on the cattle numbers per community. This information will add value to for the analysis of pasture and grasslands pressure and studies of land degradation and soils erosion.

- As part of the initial phase of the project, to develop an open-source based mobile application for field data collection and reporting that would allow to streamline and standardize the monitoring processes with real-time data transfer to the proposed information system and subsequent visualization and analysis as required.

- As part of the initial phase of the project it is recommended to digitize the Manual for Monitoring of Pastures and the Guidelines for Development and Implementation of Sustainable Management Plans for Pastures and Grasslands (Sustainable Management of Biodiversity, South Caucasus), in particular the data collection forms and make them part of the mobile application.

- To automate the generation of the Sensitivity model through scripting/programming with further integration of the plug-in with the system

- Work with the communities to facilitate filed data collection using the digital tools – the mobile application. This would provide for higher levels of community engagement and ensure the timely flow of data and information between the information system and the community users.

Overall, the result of the intervention, in the form of a pilot project of limited scope, should be significant improvement of the capacity of the department of Agricultural Programs Development, Resource Use and Cooperation Development in data collection, processing and analysis and its subsequent use for decision-making and policy formulation. These capacities and good practices will serve as a solid foundation for the future scale-up of the information system in a direction dictated by the evolving situation, infrastructure and institutional frameworks and developments.

6. References and sources

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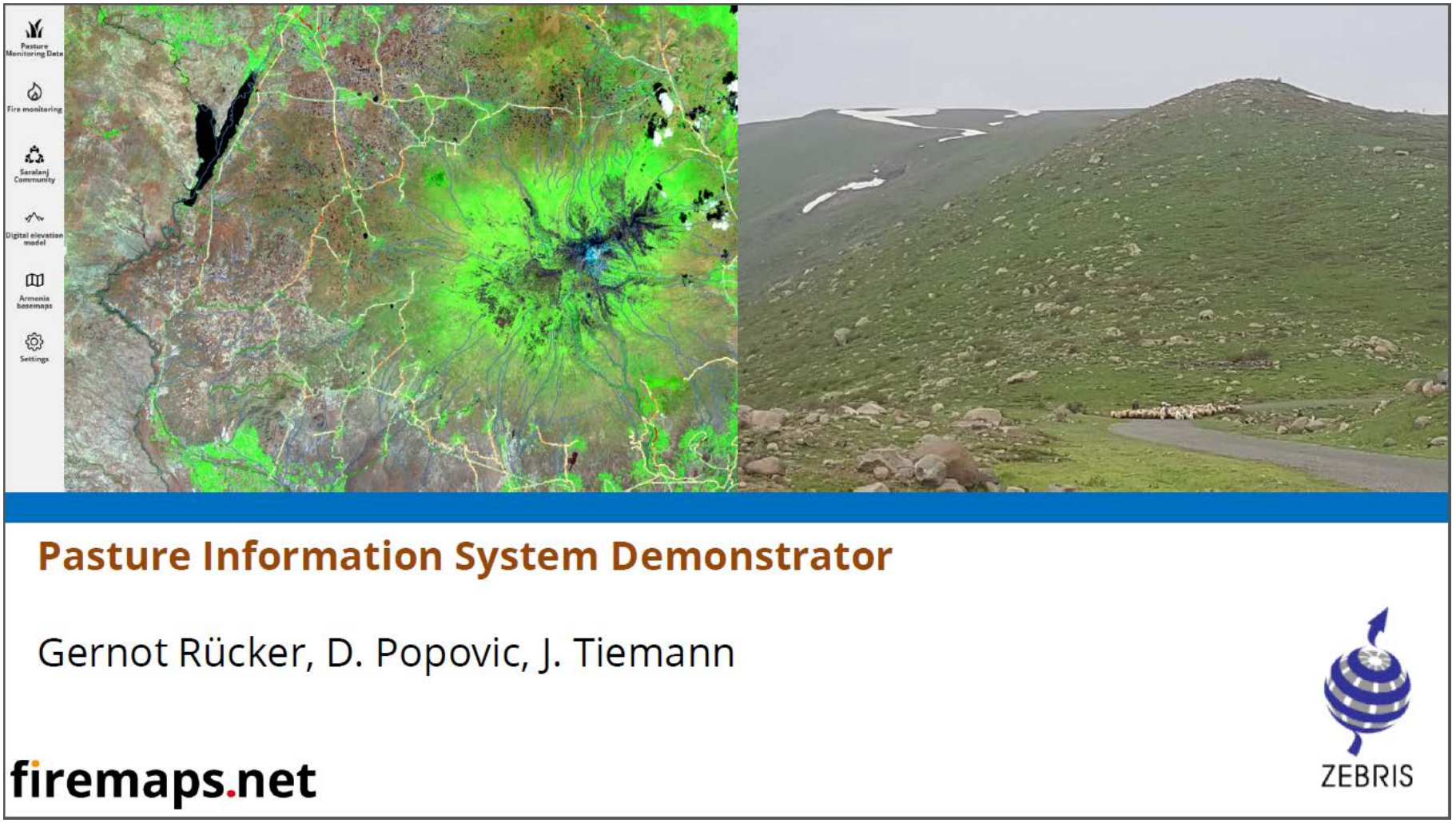
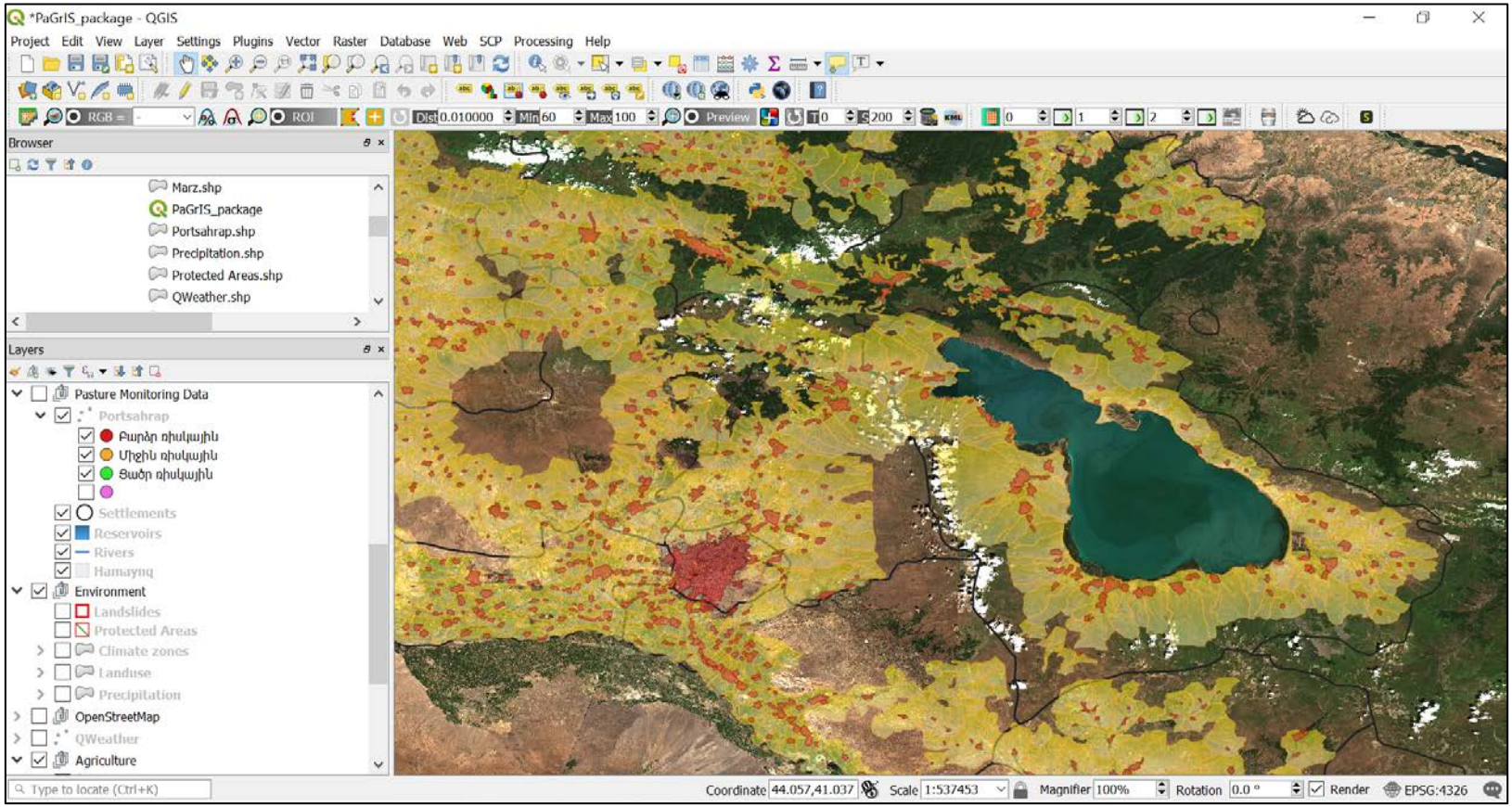
7. Appendices

7.1 Workshop presentation

7.2 Online Demo presentation by Zebris



7.3 Offline database demo



7.4 Stakeholder meeting list

	Organisation	*Representative, position*
	Ministry of Economy represented (assigned focal point) by the *Department of Agricultural Programs Development, Resource Use and Cooperation Development, Division of Agricultural Resource Use*	• Artak Kamalyan, deputy minister • Avetis Hovhannisyan, advisor to the minister • Arthur Baghdasaryan, head of Department of Land Use and Melioration • David Mejlumyan, head of Division of Agricultural Resource Use • Kristina Khanoyan, chief specialist at Division of Agricultural Resource Use • Rudik Nazaryan, head of Department of Plant Growing and Plant Protection • Levon Ter-Isahakyan, head of Department of Veterinary and Livestock Agriculture
	Ministry of Environment *Bioresources Management Agency* *Department of Underground Resources and Land Protection Policy*	 • Artem Tarzyan, head of the Bioresources Management Agency • Hasmik Ghalachyan, head of Division of Management of Specially Protected Areas of Nature and Arboretums • Kristine Baghdasaryan, head of Department of Underground Resources and Land Protection Policy • Ashot Suqiasyan • Ararat Aghabekyan
	Ministry of Territorial Administration and Infrastructure represented by the deputy-minister and the *Department of Local Self – Government Policy* and its *Division of management of Community Information Flows.*	• Lilia Shushanyan, deputy minister • Armen Martirosyan, assistant to the deputy minister • Ashot Giloyan, head of the Department of Local Self – Government Policy • Ripsime Babayan, chief specialist at the Division of management of Community Information Flows of the Department of Local Self – Government Policy • Gagik Manukyan, head of the Division of management of Community Information Flows
	"Program Coordination Platform for Sustainable Management of RA's Natural Fodder Areas: Pastures and Grasslands"	• Vardan Hambardzumyan, coordinator of platform activities

	Real Estate Cadastre Committee of Armenia represented by the *Geodesy and Cartography Department*.	• Artak Piloyan, head of Geodesy and Cartography Department.
	Statistical Committee of the Republic of Armenia Agriculture Statistics Division Information Resources Management and Technologies Department	• Arsen Avagyan, head of the Agriculture Statistics Division • Aida Martirosyan, Information Resources Management and Technologies Department
	Armenian National Agrarian University	• Vardan Urutyan, Rector • Gagik Tovmasyan, candidate of sciences, docent. Natural fodder areas management expert
	Second Community Agricultural Resource Management and Competitiveness (CARMAC II**) Project for Armenia.**	• Karen Torosyan, Coordinator of the CARMAC II, 1st component
	SDA	• Viktoria Ayvazyan
	UNDP Armenia	• Hovik Sayadyan, task leader of the Mainstreaming Sustainable Land and Forest Management in Mountain Landscapes of North-Eastern Armenia project •
	Information Systems Development And Training Center	• Grisha Khachatryan, President
	Communities	
	Sisian community ▪ Shaki ▪ Brnakot	Ruben Manucharyan, environmental protection department leading specialist Vahan Ghazaryan, head of community Andranik Harutyunyan, head of community Armen Khachatryan, head of Agriculture and Environmental protection department
	Saralanj community	

	▪ Saralanj ▪ Mets Mantash ▪ Poqr. Mantash ▪ Haritch ▪ Nahapetavan	Tsolak Hovhannisyan, head of community Zohrab Hovsepyan, 1st class specialist Narek Mkrtchyan, deputy head of community Vachagan Muradyan, director of Arts school Aramais Galoyan, chief specialist Samvel Minasyan, chief specialist Khachik Araqelyan Gor Petrosyan, head of community
	Berd community ▪ Navur ▪ Norashen ▪ Choratan ▪ Tavush	Harutyun Manucharyan, head of Berd community Aram Nigoyan, head of community Gor Abrahamyan, head of community Vardan Bazmanyan, representatve Arthur Hovhannisyan, represengative

7.5 Workshop participants list

“Program Coordination Platform for Sustainable Management of RA’s Natural Fodder Areas: Pastures and Grasslands” 5-th workshop. September 17, 2019. (Armenian version)
1. Տիգրան Գաբրիելյան – ՀՀ Էկոնոմիկայի նախարարություն
2. Արման Խոջոյան – ՀՀ Էկոնոմիկայի նախարարություն
3. Քրիստինա Խանոյան – ՀՀ Էկոնոմիկայի նախարարություն
4. Հովհաննես Աբաջյան – ՀՀ Էկոնոմիկայի նախարարություն
5. Անուշ Վերանյան – ՀՀ Էկոնոմիկայի նախարարություն
6. Սիլվա Հակոբյան – ՀՀ Էկոնոմիկայի նախարարություն
7. Շավարշ Ալեքսանյան – ՀՀ Էկոնոմիկայի նախարարություն
8. Եկատերինա Խաչատրյան – ՀՀ Էկոնոմիկայի նախարարություն
9. Հռիփսիմե Բաբայան – ՀՀ Տարածքային կառավարման և ենթակառուցվածքների նախարարություն
10. Գարեգին Մանուկյան – ՀՀ Տարածքային կառավարման և ենթակառուցվածքների նախարարություն
11. Ոսկեհատ Գրիգորյան – ՀՀ Շրջակա միջավայրի նախարարություն
12. Արմինե Մկրտչյան – ՀՀ Շրջակա միջավայրի նախարարություն
13. Մարիամ Մարգանյան – ՀՀ Բարձր տեխնոլոգիական արդյունաբերության նախարարություն
14. Անի Մխիթարյան – ՀՀ Բարձր տեխնոլոգիական արդյունաբերության նախարարություն
15. Հովիկ Սայադյան – Միավորված Ազգերի Զարգացման Ծրագիր
16. Հրաչյա Զաքոյան – ՀՀ Ազգային Ագրարային համալսարան
17. Հայկ Երիցյան – ՀՀ Կադաստրի Կոմիտե
18. Աիդա Իսկոյան – ԵՊՀ Իրավաբանական ֆակուլտետ, էկոլոգիական իրավունքի կենտրոն
19. Արմեն Խաչատրյան – Սիսիանի համայնքապետարան
20. Ռուբեն Մանուչարյան – Սիսիանի համայնքապետարան
21. Անդրանիկ Հարությունյան – Սիսիանի համայնքապետարան
22. Աղավնի Հարությունյան – Հայաստանի Ամերիկյան Համալսարան
23. Միշել Կրիստեն – Հայաստանի Ամերիկյան Համալսարան

24. Լուսինե Թումանյան – ՀՀ Վիճակագրական Կոմիտե
25. Կարեն Թորոսյան – Գյուղատնտեսության զարգացման հիմնադրամ
26. Կարինա Հարությունյան – Ռազմավարական զարգացման գործակալություն ՀԿ
27. Վարդան Համբարձումյան – Ռազմավարական զարգացման գործակալություն ՀԿ
28. Գագիկ Թովմասյան – Ռազմավարական զարգացման գործակալություն ՀԿ, ՀԱԱՀ
29. Վիկտորյա Այվազյան – Ռազմավարական զարգացման գործակալություն ՀԿ
30. Աստղիկ Դանիելյան – Գերմանիայի միջազգային համագործակցության ընկերություն
31. Արմեն Ասրյան – Գերմանիայի միջազգային համագործակցության ընկերություն
32. Մուշեղ Մկրտչյան – Գերմանիայի միջազգային համագործակցության ընկերություն
33. Քարոլին Վագներ – Գերմանիայի միջազգային համագործակցության ընկերություն
34. Սամվել Հովհաննիսյան – Գերմանիայի միջազգային համագործակցության ընկերություն
35. Գայանե Նալբանդյան – Գերմանիայի միջազգային համագործակցության ընկերություն
36. Երանուհի Հակոբյան – «Ըդվայզ» խորհրդատվական
37. Լիլիթ Ղարայան – «Ըդվայզ» խորհրդատվական

7.6 Estimated budget for the initiation phase of the project

The estimated budget for the pilot stage of the proposed data-centric system covers the first 12 months of the implementation (24 months for software and service subscriptions). The budget covers the capacity building within the Ministry of Economy in the form of on-the-job training, purchase of computer and server hardware, service subscriptions for EO analytical products and software licences, software development (scripting of image processing automation tools and development of mobile application for field data collection).

It is recommended to utilise proprietary and industry leading ArcGIS software suits by ESRI given their relatively low cost for annual non-commercial use license while ensuring the exposure of the trainees to the open-source QGIS software and its environment.

Table 12: Estimated budget

Item	Unit	Rate (usd)	Units	Total	Notes
Capacity building					
GIS/RS/ICT4D for managers	training	1,500	1	1,500	For senior management, up to x3 participants
GIS advanced user training	training	2,000	1	2,000	ArcGIS (and/or QGIS) x3 civil servants, covering thematic areas of applications
Image processing advanced train.	training	2,000	1	2,000	ArcGIS (and/or QGIS), x3 civil servants covering thematic areas of applications
GIS and Remote Sensing expert	Man/month	1,200	6	7,200	To assist the host institution in data and map development, part-time (0.5) engagement within a 12 months period.
Database Management, IT expert	Man/month	1,600	6	9,600	To assist the host institution in database development, setup and support, part-time (0.5) engagement within a 12 months period.
Fieldwork (transport.) expenses	lumpsum	1.00	1	5,000	Field visits and verifications, ground truthing. 2,000km total travel distance, at a rate of USD 1.00/sq.km. and associated field expenses. May include off-road driving to inaccessible areas.
Computer hardware					
Server	Server		1	1,500	High capacity server (with data storage being the primary function) with at least 8TB storage. A dedicated PC may be used for this function.
Personal computer	PC	2,000	2	4,000	Processing power fit for image processing (Intel core i7, RAM 16GB, 2TB HDD storage, dedicated graphics)
Storage devices	Storage device		2	500	External Network HDD drives for archival data storage

	Software development					
	Automation tools	scripts			5,000	Soils Sensitivity calculation automation tool for QGIS and ArcGIS. Optional, may be carried forward to the next implementation phase.
	Mobile app development	application			6,000	Based on an open-source platform for both Android and iOS
	Service subscriptions					
	Sentinel Hub - EO browser				300	Analytical EO products based on Sentinel imagery. Individual, Non-commercial use licence for 24 months https://apps.sentinel-hub.com/eo-browser
	ESRI ArcGIS				400	Two year licence for non-commercial use, 2 PCs
	Contingency				5,000	Unexpected costs, variations (~10% of the estimated budget)
	TOTAL				**50.000**	

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