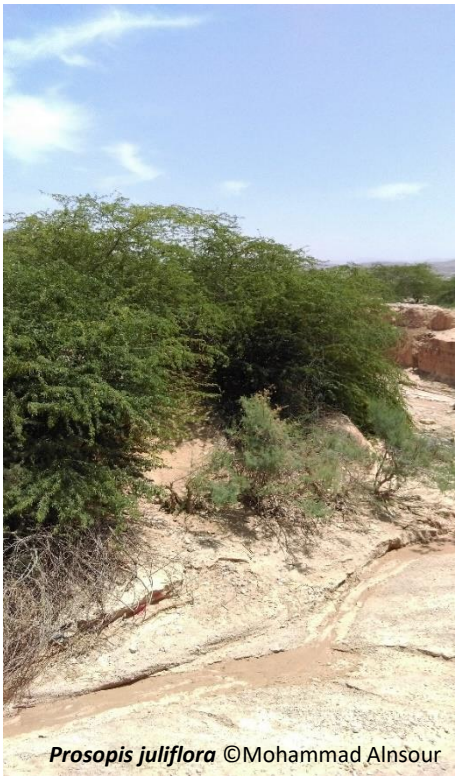
National Strategy to improve the Control of Invasive Alien Species (2021-2030)


Cyprinus carpio ©Nashat Hmedan


Myocastor coypus©Ehab Eid


Acridotheres tristis©Fares Khouri


Prosopis juliflora ©Mohammad Alnsour

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Abbreviations

ASEAZA	Aqaba Special Economic Zone Authority
BRP	Badia Restoration Program
BWC	Ballast Water Convention
BW	Ballast Water
CBD	United Nations Convention on Biological Diversity
CBO's	Community Based Organizations
GIZ	German Agency for International Cooperation
IAS	Invasive Alien Species
IUCN ROWA	International Union for the Conservation of Nature- Regional Office for West Asia
JREDS	Royal Marine Conservation Society of Jordan
JMA	Jordan Maritime Authority
JVA	Jordan Valley Authority
MEA	Millennium Ecosystem Assessment
MOA	Ministry of Agriculture
MOE	Ministry of Education
MOENV	Ministry of Environment
MOHE	Ministry of Higher Education and Scientific Research
MOMA	Ministry of Municipals Affairs
MOPIC	Ministry of Planning and International Cooperation
MOTA	Ministry Of Tourism and Antiquities
MOWI	Ministry of Water and Irrigation
NARC	National Agriculture Research Center
NBC	National Biodiversity Committee
NBSAP	National Biodiversity Strategy and Action Plan
NGO's	Non-Government Organizations
PAF	Princess Alia Foundation
QAIA	Queen Alia International Airport
QRTA	Queen Rania Teachers Academy
RBG	Royal Botanic Garden
RGC	Royal Geographic Center
RSCN	Royal Society for the Conservation of Nature
RSS	Royal Scientific Society
SDG's	Sustainable Development Goals

1. Introduction

1.1. General features of the Jordanian environment

Jordan is a relatively small country of an area around 89,000 sq km. It is located in the eastern Mediterranean and considered mid-income country with a population of 10M inhabitants composed mainly of youth; around 70% of the population is 30 years or younger and known by high literacy rate[1][2].

Four distinct bio-geographic zones can be recognized in Jordan which are the Irano-Turanian, Mediterranean, Sudanian penetration and the Saharo-Arabian zones. The latter composes around 80% of the country's area (figure 1a) [3][4].

a. b.

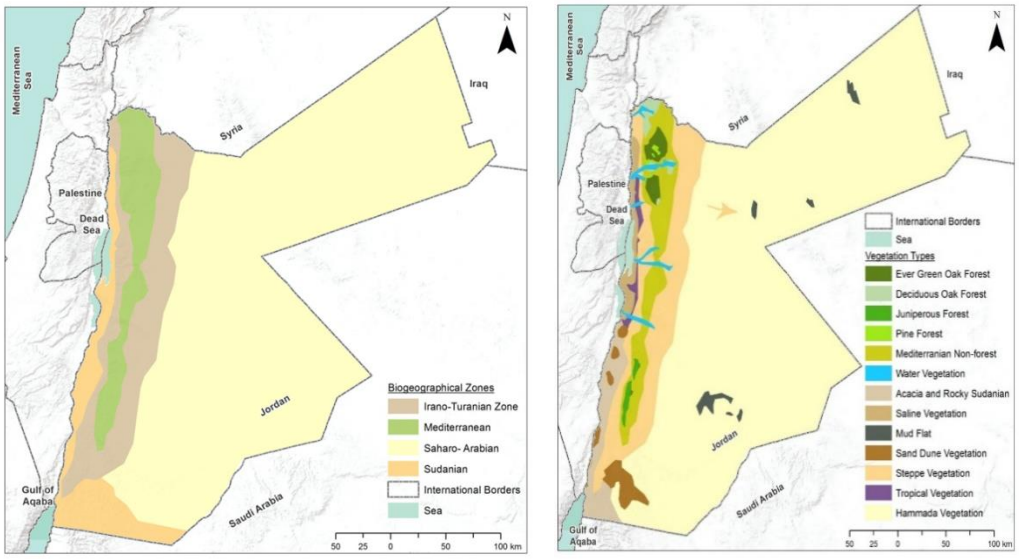


Figure 1: (a) Bio-geographic zones of Jordan; Mediterranean, Irano-Turanian, Sudanian and Saharo-Arabian. (b) 13 distinct vegetation types can be identified in Jordan.

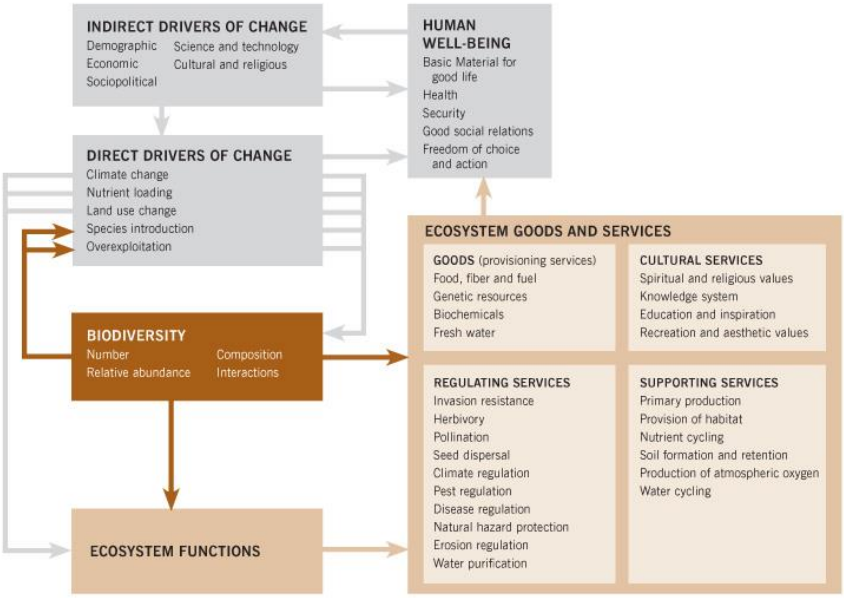
The variability in elevation, geographic features and climatic characteristics enhanced the development of 13 different vegetation types (figure 1b). The variety of vegetation types supported the existence of more than 2,600 vascular plant species, which represents 1% of global plant biodiversity, so Jordan is considered as one of the worlds' biodiversity hotspots.

[1] 5th national report to the United Nations Convention on Biological Diversity, 2014.
[2] http://dosweb.dos.gov.jo/ar/ (Department of statistics website).
[3] Al-Eisawi, D. 1996. Vegetation of Jordan. Regional Office for Science and Technology for the Arab States.
[4] 5th national report to the United Nations Convention on Biological Diversity, 2014.

Furthermore, a total of 644 animal species including 83 mammals, 15 freshwater fishes, 436 birds, 106 herpetofauna have been recorded from Jordan. In addition, more than 500 species of marine fishes were recorded in the 27km of the Gulf of Aqaba, in addition to 157 hard corals species, three sea turtles, three seagrasses and thousands of marine invertebrates[5].

1.2. Ecosystem services and threats to biodiversity

Many reports link biodiversity with natural ecosystems functioning. Ecosystems functions usually perceived as services (benefits) when they are attributed to human wellbeing. Loss of biodiversity will, ultimately, affect provided services and, eventually, cause their loss. Ecosystem services can be provisioning, regulatory, sustaining or cultural. Few examples of these services include, provision of water, food, and feed, soil stabilization, carbon sequestration, climate regulation and recreation[6]. Biodiversity loss can be linked to one of five main direct threats; Land use change and habitat loss, over-exploitation, nutrient loading (pollution), climate change and Invasive Alien Species (IAS) (figure 2)[7].



[5] 5th national report to the United Nations Convention on Biological Diversity. 2014.
[6]Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC
[7]Secretariat of the Convention on Biological Diversity. 2006. Global Biodiversity Outlook 2. Montreal, 81 + vii pages

Figure 2: Biodiversity is essential for ecosystems services necessary for human wellbeing. Anthropogenic pressures, including IAS, will trigger biodiversity loss and impact negatively on ecosystem services.

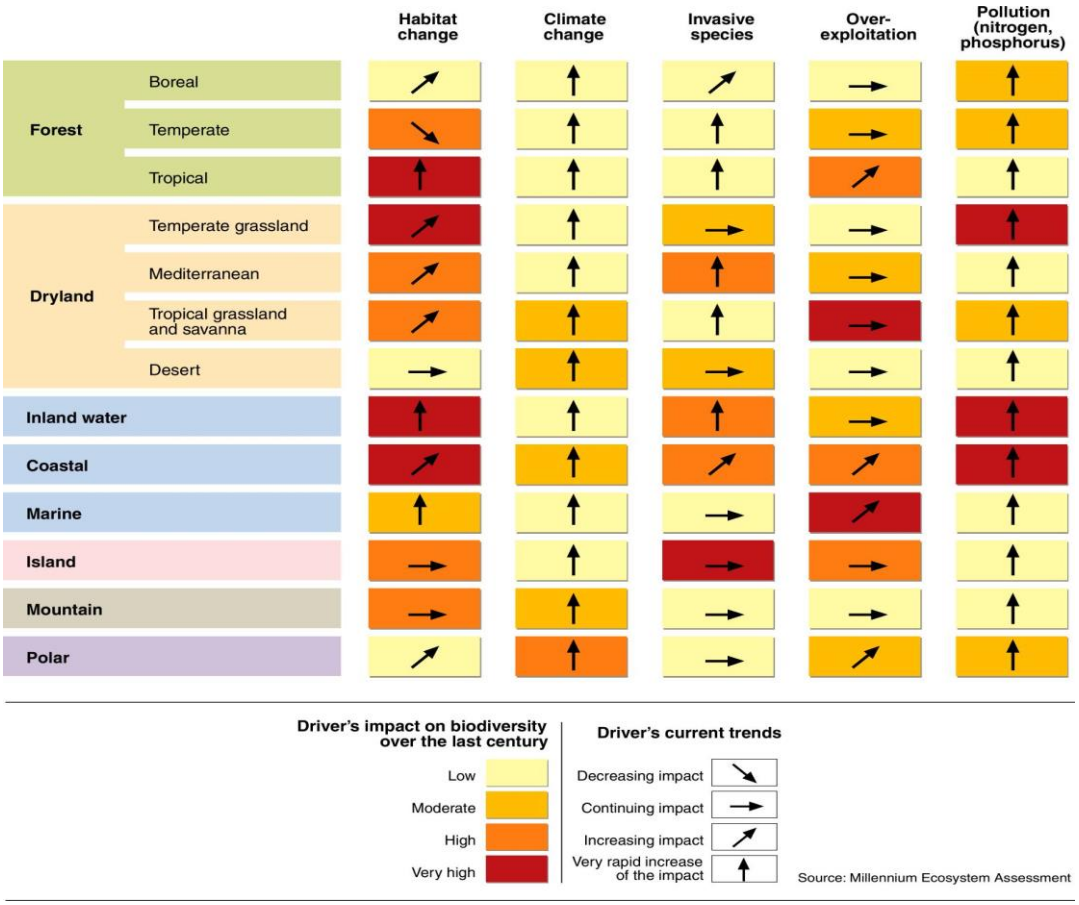


Figure 3: Main threats to biodiversity. The Mediterranean region is very susceptible to IAS high impact. MEA also anticipated a very rapid increase of IAS impact in the future.

The risk of IAS has been well recognized since the 17th century, as more than 40% of extinct animal species was linked with IAS[8]. In 2005, the Millennium Ecosystem Assessment (MEA) indicated that IAS pose high threat to biodiversity in the Mediterranean, and that threat is increasing very rapidly (figure 3)[9]. For that, controlling invasive alien species was considered among Aichi biodiversity targets (target 9), and sustainable development goals (SDG's; target 15.8). Table 1 shows the script of these target as set by international *fora*.

[8] https://www.cbd.int/idb/2009/about/cbd/

[9] Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC

Table 1: Script of Aichi target 9 and SDG target 15.8 regarding IAS control.

Aichi target No. 9 	***By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.***
SDG target No. 15.8 	***By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species***

2. Invasive alien species

2.1. Invasive alien species definition and main features

According to the United Nations Convention on Biological Diversity (CBD), IAS can be defined as "***species whose introduction and/or spread outside their natural past or present distribution threatens biological diversity***". A common characteristic of IAS is their high dispersal ability, on the other hand, they show rapid reproduction and growth and adaptability to various habitats. History of previous successful invasion in other areas is a good predictor of invasiveness potential in similar conditions. IAS have adverse impacts on biodiversity; like disruption of ecosystems and their functions and harmful effects on native species through competition, predation, or transmission of pathogens[10].

2.2. Invasion stages and management options

Globalization resulted in greater trade, transport, travel and tourism which facilitates the introduction and spread of alien and exotic species into new habitats. Introduced species may survive and reproduce if they were introduced to habitats similar enough to a species' native habitat. Alien species might invade new habitats if they manage to get established and out-compete native species for available resources. Later, these species will increase in population size and spread to new locations and negatively affect native species and harm ecosystems[11].

In general, any successful invasion process can be divided into four main stages (figure 4)[12].

Introduction: this can happen accidently such as in the case of contaminated seed pouches, or intentionally through importation of ornamental and exotic species. The invasion process starts once these species manage to escape into nature. Control of IAS at this stage is the most effective and cost-efficient alternative. Yet, this requires strong technical knowledge and elaborated lists of potential invading species. These should be used together with sound regulatory framework at the borders and inside countries to limit species introduction and escape into nature.

[10] United nations convention on biological diversity web site (https://www.cbd.int/invasive/WhatareIAS.shtml)
[11] https://www.cbd.int/idb/2009/about/cbd/
[12] https://invasives.org.au/wp-content/uploads/2014/02/Invasion-pathway.png

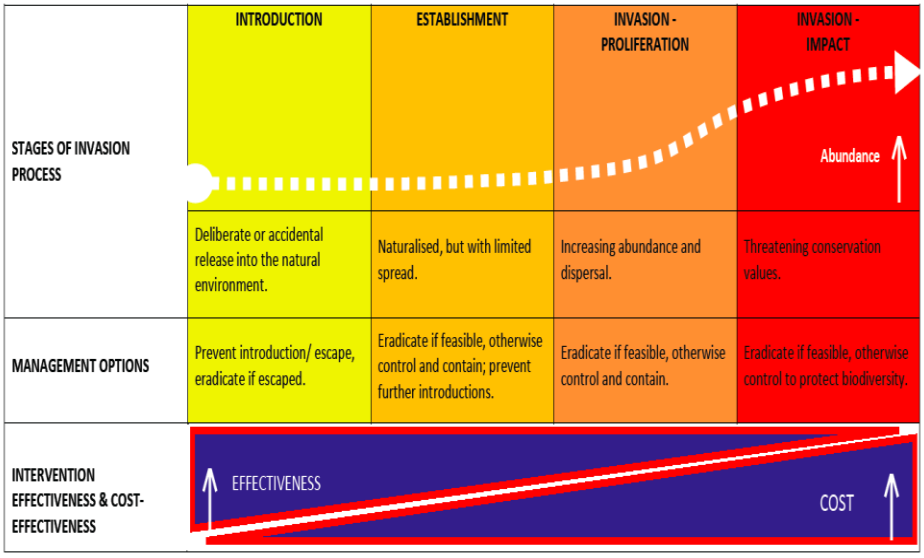


Figure 4: Summary of invasion stages, management options and their cost.

Establishment: These species are well established (naturalized) at this stage, but there is only limited increase in their numbers. IAS should be contained at this stage and eradicated if feasible.

Invasion proliferation: IAS starts to increase in number and expand to other areas at this stage. Eradication is very difficult, and cost increases rapidly, usually management practices at this stage focus on species control and containment.

Invasion impact: at this stage, IAS becomes abundant and their impact on biodiversity, ecosystems and their services and livelihoods becomes visible. Eradication is very expensive and almost impossible to achieve. Management should focus on containing these species to protect biodiversity and ecosystems services and utilize their benefits for human wellbeing, if possible.

2.3. Development of invasive alien species issue in Jordan

Intentional introduction of alien species to Jordan is thought to have started since the 19th century (might have been occurred earlier) and accelerated tremendously during the past 50 years[13]. The introduced species were used for several purposes including pet trade, as ornamental species and to serve development purposes. Other species were also introduced

[13] Khoury. F; Amr, Z; Hamidan, N; Alhassani, I; Mir, S; Eid, E and Bolad, N. 2012. Some introduced vertebrate species to the Hashemite Kingdom of Jordan. Vertebrate Zoology. 63(2), 435-451.

unintentionally with contaminated shipments or as hitch hikers (birds) of ships and boats. Many introduced species managed to escape, invading natural ecosystems and form self-sustaining communities.

Table 2: Priority invasive alien species in Jordan*.

Terrestrial ecosystems					**Aquatic Ecosystems**	
Flora	**Fauna**				**Marine**	**Freshwater**
	Mammalian	**Reptiles**	**Birds**	**Insects (Bees)**		
Prosopis juliflora	*Myocastor coypus*	*Cyrtopodion scabrum*	*Acridotheres tristis*	*Apis florea*	*Sparus aurata*	*Cyprinus carpio*
Ailanthus altissima	*Rattus rattus*	*Trachemys scripta elegans*	*Corvus splendens*		*Dicentrarchus labrax*	*Gambusia holbrooki*
Acacia saligna	*Rattus norvegicus*		*Columba livia domestica*		*Plotosus lineatus*	*Poecilia reticulate*
Nicotiana glauca	*Mus musculus*		*Euodice malabarica*		*Mnemiopsis leidyi*	
Atriplex nummularia			*Pycnonotus leucotis*			
Solanum elaeagnifolium			*Psittacula krameria*			

*Table was developed based on the work and observations of a group of national experts through support from GIZ funded project “sustainable use of ecosystem services in Jordan (EKF-ESS)”.

Globally, IAS invaded almost all living biomes. In Jordan, invasive alien species (IAS) invaded wide variety of habitats and ecosystems and thought to impact native plants, mammals, reptiles, birds, insects, freshwater and marine ecosystems species. Table 2 provides the list of main invasive alien species reported from Jordan. It is worth to highlight that IAS in Jordan require in-depth thorough investigation of their current status, attributes of invading species and invasion process dynamics in order to develop plans to respond to each invasion incident effectively.

Jordan is invaded by some of the world's worst invading species known[14], but not all of them revealed their negative impacts yet. Priority worst invaders of Jordan include:

1. ***Acridotheres tristis*** (Common myna) birds were first spotted in 2004, and no breeding was reported until 2012[15]. Nowadays, common myna is occupying wide areas in North-Western Jordan (figure 5, this species was also spotted to the south near Fifa and other areas across Jordan. These locations were not captured in this map which was last updated in 2019).

2. ***Prosopis juliflora*** (Mesquite) plants thought to be introduced to Jordan in the 1980's of the past century. Nowadays they are occupying most of the Jordan Valley (Figure 5). *Prosopis* extent of occurrence (invaded area) is estimated to a bit more than 1800 km^2 [16]. One major cause of this species' infestation is degradation of natural vegetation due to over-grazing[17]. Furthermore, grazing animals function as vectors and facilitate the spread of *P. juliflora* seeds to other areas.

3. ***Cyprinus carpio*** (Carp) is also invading many freshwater habitats in Jordan and impact negatively on them (Figure 5). Carp manipulates the characteristics of aquatic environment to make it optimal for its growth, and sub-optimal, or even not usable for other species [18].

4. ***Myocastor coypus*** (Nutria) invaded areas near Yarmouk River after escaping from fur farms in the surrounding countries (Figure 5).

[14] http://www.issg.org/pdf/publications/worst_100/english_100_worst.pdf (100 0f the world's worst alien invasive species, 2004)

[15] Khoury. F; Amr, Z; Hamidan, N; Alhassani, I; Mir, S; Eid, E and Bolad, N. 2012. Some introduced vertebrate species to the Hashemite Kingdom of Jordan. Vertebrate Zoology. 63(2), 435-451.

[16] Dufour-Dror. J-M and Shmida. A . 2017. Invasion of alien Prosopis species in Israel, the West Bank and western Jordan: characteristics, distribution and control perspectives. BioInvasions Records. 6(1), 1-7.

[17]Khoury. F& Korner. P. 2019. Grazing in remnant wetland habitats in an arid region: direct and indirect effects on two specialist bird species. Bird Study, DOI: 10.1080/00063657.2018.1563046

[18]Badiou. P; Goldsborough. G and Wrublesk. D. Impacts of the common carp (cyprinus carpio) on freshwater ecosystems: a review. 2011. *In: Carp: Habitat, Management and Diseases*. Editor: Sanders J. D. and PetersonS. B., Nova Science Publishers, Inc. pp. 1-20. ISBN 978-1-61324-525-5

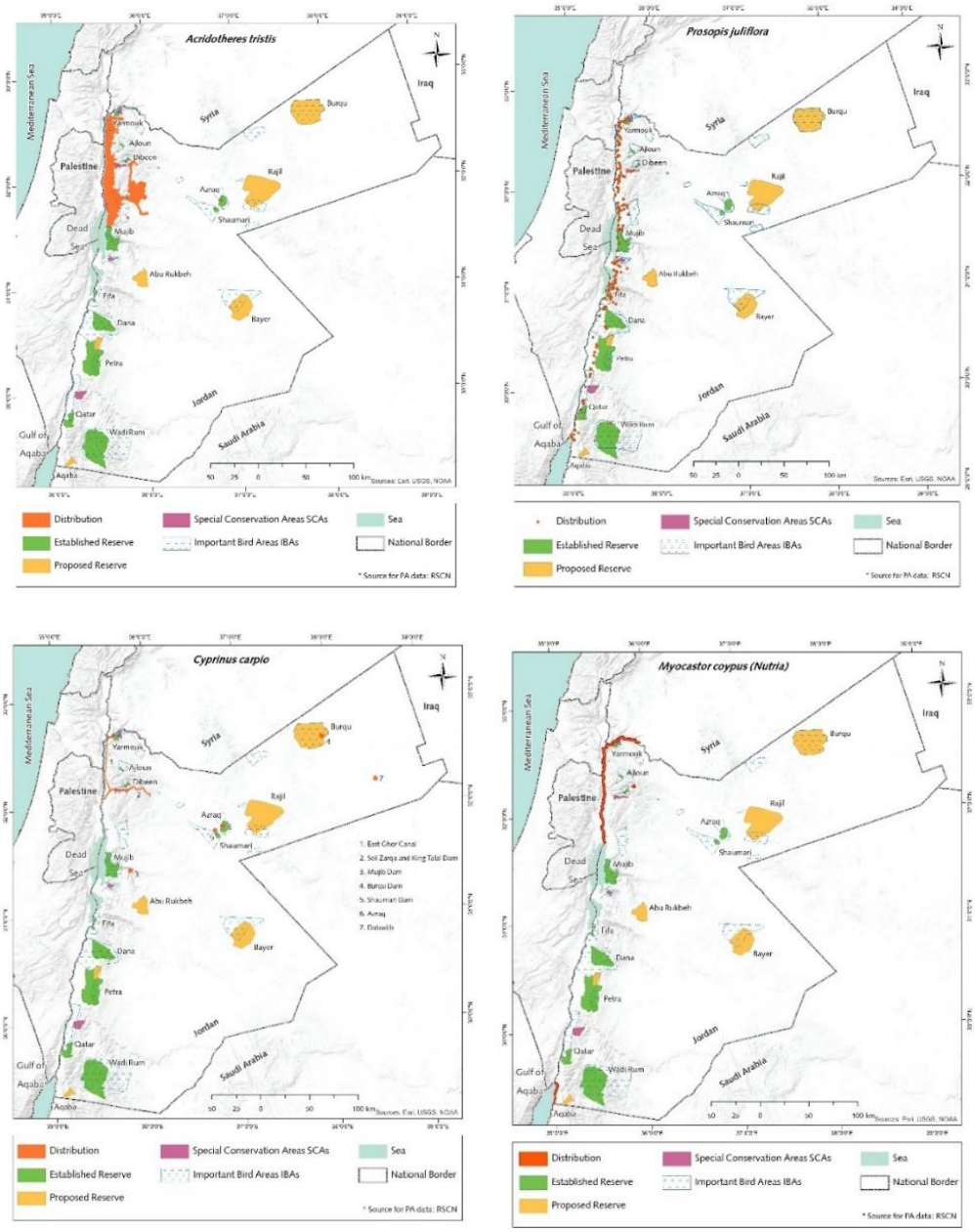


Figure 5: Occurrence maps of worst invading species in Jordan were developed in 2019 based on experts' observations. Since then, some species invaded additional areas, but these locations were not captured here.
(up, left) *Acridotheres tristis* (bird) occupy wide areas in Northern-Western Jordan. (up, right) *Prosopis juliflora* (plant) occupying most of the Jordan Valley. (below, left) *Cyprinus carpio* (fish) invaded many important freshwater habitats. (below, right) *Myocastor coypus* (mammal) spotted in areas to the east and south of Jordan in addition to its initial invasion location near Yarmouk River.

The impact of some IAS on native species and natural ecosystems is obvious, while the impact of other species waits to be discovered. Baseline assessments of currently invading species, prioritizing them and studying their impact and control measures are essential for the development of proper regulatory framework. Efforts should also focus on identifying introduction pathways and possible regulatory considerations. As IAS dynamics and invasion strategies can be deceiving, protection might be the best approach to follow. For that, developing appropriate approaches is crucial to prevent future introduction and control IAS expansion.

2.4. Ecosystem resilience to invasive alien species invasion in Jordan

Probability of invasion success correlates negatively with ecosystems health and integrity. Unfortunately, most of natural ecosystems in Jordan seem to be vulnerable to biological invasion as they are degraded, open in density and fragmented due to different human activities. Many nationally identified priority invasive species (table 2) have been figured out in degraded ecosystems like the Jordan Valley. IAS found in urban and peri-urban areas are mainly located in ruins and sidewalks. Natural ecosystems in Jordan are also plagued by some of the worst invasive species (Section 2.3. above); *Prosopis juliflora* (plants), *Acridotheres tristis* (birds), *Myocastor coypus* (mammal), *Cyprinus carpio* (freshwater fish).

Jordan suffers from limited technical capacity regarding the issue of IAS. Furthermore, relevant regulations to control IAS introduction, propagation, distribution and control are almost absent and/ or not implemented.

Improving Jordan resilience to IAS requires building national capacity to prevent deliberate and accidental introduction of IAS and to regulate current invading species. Moreover, appropriate regulations should be formulated and enforced by law. Focus should also be given to limit degradation drivers and improve ecosystems integrity and conserve biodiversity to create more resilient ecosystems.

2.5. Invasive alien species; economic and social considerations

IAS have been introduced intentionally to different countries to serve various environmental and developmental goals. For that, they are expected to provide some benefits. Yet, most countries are facing complex and costly invasive species problems. Calculating the cost of invasion is very complicated due to its various direct and indirect negative impacts. By some estimates, IAS are assumed to cause 1.4$ Trillion of annual losses. This is supported by examples from around the world. For example, the annual damage costs of invasive species in the United States, United Kingdom, Australia, South Africa, Canada, Germany, Ireland, Sweden and India can vary and reach up to 12% of the national gross domestic production (GDP). Addressing the problem of invasive alien species is urgent because the threat is growing daily, and the social, economic and environmental impacts are severe.

In Jordan, around 50 plant species were introduced for soil stabilization, landscaping and forage production. For example, *Prosopis juliflora* (the local name is Al-Salam tree) in the Jordan Valley (JV) was introduced to rehabilitate roadsides and bare lands prone to grazing in the 1980's. Since then, the local communities have recognized various benefits from using the plant as an energy source; forage for grazing animals and as a nectar source for bees. Nevertheless, the same communities also identified the negative impact of these trees such as injuries caused by long hard thorns to community members and grazing animals and reducing available arable land due to reduction of land available for cultivation. *Prosopis* trees reveal significant economic opportunities to provide fuel wood and charcoal and to enhance the recreational service in this area following proper tree trimming and control. Enhancing such services requires revisions and modifications of the governmental regulations for utilizing the tree benefits. These findings and initial valuation of *Prosopis* invasion impact on socio-economic aspects were investigated in the Jordan Valley by GIZ support. However, more studies are required to assess the impacts of priority IAS in Jordan. Thus, draw a comprehensive understanding of IAS threats and potentials in Jordan.

The social impact of IAS is also significant as they cause health issues, affect social interactions, result in harsher living conditions and deprive marginal local community groups of alternative resources; a study conducted in Northern Jordan showed that such groups appreciated more the importance of services provided by natural ecosystems.

The perception of IAS impact, either negative or positive, on social and economic aspects will be affected by the nature of activities practiced by certain communities and specific community members. For that, comprehensive studies and assessments, both economic and social, are required to analyze the multifaceted impacts of IAS. These studies should include direct and indirect impacts and focus on the benefit of the population majority in the long run and consider IAS management.

2.6. Information generation, exchange and awareness raising

Currently, there is limited information regarding IAS and invasion impact on natural ecosystems and local communities in Jordan. Yet, there are a few exceptions of studies conducted on IAS. The most elaborated efforts have been conducted in studying *Prosopis juliflora* invasion of the Jordan Valley. This was conducted by Integrated Ecosystem Management in the Jordan Rift Valley project (2007-2013), which was implemented by the Royal Society for Conservation of Nature (RSCN). Recently, more studies are being carried out through the German Development Agency (GIZ) funded project, sustainable use of ecosystem services in Jordan (EKF-ESS). Another good example is the work conducted also by RSCN to control freshwater invasion in Azraq wetland.

Awareness raising programs are also very limited and are not tailored to various groups of interest. Thus, IAS issue is not well recognized and often dealt with lightly by decision makers, practitioners and local communities.

There is a need for a comprehensive scientific research of diverse issues related to biological invasion and their potential impacts. Generated information should be shared among relevant institutions and would ideally be used to raise the awareness of stakeholders including local communities and decision makers. Thus, support informed decision-making process and ensure proper community engagement. This should help to, improve the control of such species introduction and manage established ones more efficiently.

3. Governance of Invasive alien species in Jordan

3.1. Invasive alien species; national development plans and international commitments

IAS have been introduced to many countries for development purposes due to their desirable characteristics. Now, it is clear that these benefits came with huge threats on ecosystems and human livelihood.

Jordan adopted green sustainable approaches to support its national development plans; national green growth plan clearly stated the need to conserve and enhance biodiversity and ecosystem services as one of the plan's main five outcomes[19]. As IAS impact negatively on biodiversity and services provided by natural ecosystems, these species should be controlled to contain their effects. IAS impact on biodiversity and need to control them have been documented in various national reports including the national biodiversity strategy and action plan (NBSAP)[20]. Control of IAS will assist national efforts to fulfill their obligations to international conventions such as the United Nations convention on biological diversity (CBD) and the sustainable development goals (SDG's). A report published in July 2018 showed that Jordan ranked 91 out of 156 countries in achieving the SDG's[21]. Hence, efforts to achieve various goals including goal 15, which include measures to control IAS, requires improvement.

3.2. Institutional setup and coordination

Ministry of Environment (MoENV) is the responsible agency in Jordan as per raising the awareness regarding the threats posed by IAS and to support national efforts to control them. Then, to follow up with relevant institutions on implementation of proposed activities. Nevertheless, IAS management requires the active engagement and cooperation of various institutions for efficient control of IAS.

Many national institutions do not seem to be fully aware of IAS issue and their negative impacts. For that, there is very weak coordination in that regard. MoENV through GIZ funded project sustainable use of ecosystem services in Jordan "EKF-ESS" gathered various key stakeholders to discuss issues relevant to IAS. Workshop participants expressed that effective coordination requires solid scientific background, clear harmonized legislative framework and administrative

[19]Ministry of Environment. 2017. A National Green Growth Plan for Jordan, Amman, Hashemite Kingdom of Jordan
[20] Ministry of Environment. 2014. Biodiversity Strategy and Action Plan, Amman, Hashemite Kingdom of Jordan
[21]Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. 2018. SDG Index and Dashboards Report 2018. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

procedures. Hence, there should be a developed list of species to be controlled and scientific basis for including them among IAS. A clear approach should be developed on how to deal with incidents to introduce such species into Jordan through borders. Management of previously introduced IAS requires also proper legislative framework and coordination mechanisms. Thus, reduce negative impacts and optimize the benefits provided by these species.

3.3. Invasive alien species and civil society

IAS impacts is not well recognized by most civil society groups. Thus, they are not included in their efforts to achieve national development goals. Unfortunately, this has led to many negative impacts on the long run. Introduction of various alien species due to their desirable attributes are still practiced heavily by civil society organizations; introduction of alien, sometimes even designated invasive, plants, fish, mammals, reptiles, birds and insects to be used as pets or for economic and developmental reasons.

Awareness raising programs should be developed to inform civil society groups about the negative impact posed by introducing alien and invasive species. Some NGO's possess long experience in dealing with IAS. For that, they can be valuable partners in this process. For example, RSCN efforts in managing invasion occurring in Azraq Oasis is remarkable. The Royal Botanic Garden (RBG) and National Agriculture Research Center (NARC) are also considered national assets for issues relevant to invasion incidents among plant species. National experts from Jordanian universities and research institutes are also valuable resources for knowledge generation and building the national capacity of civil society organizations on issues relevant to IAS.

An appropriate legislative framework with clear guidance is also required to improve the control of IAS introduction and utilization by various civil society members and to facilitate their engagement in national integrated plans to control IAS.

3.4. Legislative framework for controlling invasive alien species

MoENV and "EKF-ESS" conducted a rapid assessment of some relevant ministries on the adequacy of the current legislative framework to control IAS. Regulations of Ministry of

Agriculture (MoA) and MoENV contain articles that can be used to improve the control of IAS in Jordan. Yet, these regulations are found on different legal levels; those of MoENV can be used on the general supervision level and used as guidance for other institutions to protect the environment, natural ecosystems and native species. Legal instruments of thematic institutions, such as those of MoA are more relevant to regulate IAS and support the implementation of identified required measures.

For that, revising and harmonization of different relevant agencies' laws and legislations are required to ensure their adequacy and remove conflicting articles. This is especially relevant to IAS as they should be managed by various agencies.

3.5. Financing mechanisms and arrangements

IAS is a matter of international and national concern. As they impact adversely on biodiversity, they will impact national development plans as well. Conventional and innovative financial resources should be mobilized and sustained in the long run based on all existing financing schemes to develop an adequate coherent sustainable financing system to improve the control of IAS in Jordan. Mostly this would be possible through a strategic mix of all available financing means.

Creating incentives for private sector investments and local community engagement through government initiatives and facilitation of payment for environmental services schemes, disposal of communities to utilize IAS- derived ecosystem services, NGOs and CBO's engagement, would be among the drivers to be strengthened.

The role of the private sector for the valorization of potential IAS benefits, particularly in value chain development is crucial until a suitable control measures are being defined and implemented. The involvement of local communities should be enhanced and opportunities for income generation possibilities created.

3.6. Need for invasive alien species strategy

IAS pose a great threat to biodiversity in Jordan. This will affect natural ecosystems and services provided by them. Many national plans consider ecosystem services to achieve national development and human wellbeing. Thus, IAS may have negative impacts on these efforts.

IAS are very diverse and known to have the capacity to impact almost all biomes. For that, their control requires coordination among various institutions, which have different mandates, institutional set up and legislative framework/s. This can be possible only through developing a national strategy that summarizes main national needs, interests and aspirations in a clear and structured manner. This strategy should include technical aspects to control introduction of alien species to the country and manage existing invasive species, and consider institutional, social and economic aspects. Development of this strategy will be fortifying national efforts to respond to global challenges and adhere to international agreements.

3.6.1 Strategy formulation process

Strategic modality of IAS strategy was developed based on continuous adaptive participatory approach that was launched in 2016. Stakeholder's feedback and comments were documented. A group of national experts identified gaps in national knowledge and required actions. This contributed largely to the formulation of this strategy in practical terms.

Development of strategic goals and identification of priority interventions were conducted using a participatory bottom-up approach. This methodology ensures the harmony of developed strategy with national commitments and international orientations. Furthermore, short term interventions were identified according to stakeholders' priorities, and on many occasions, they support national institutions efforts and ongoing programs.

4. Logical framework for invasive alien species strategy

In line with the identified challenges, needs and national aspirations, the vision for invasive species strategy is formulated as follow:

"By 2030, Jordan environmental, social and economic resilience toward IAS strengthened, their root causes controlled, and potential introduction and expansion is prevented.

4.1. Guiding frameworks and principles for alien invasive species strategy development and implementation:

IAS strategy has been developed in harmony with the National Biodiversity Strategy and Action Plan (NBSAP), which states the necessity to adopt some strategic goals by the government of Jordan where invasive alien species are recognized as part of the efforts to respond to human induced pressures. In addition, nature protection bylaw, which was prepared by the department of nature conservation at the Ministry of Environment, has highlighted legal perspectives of invasive alien species. The strategy would assist the government of Jordan to fulfill its obligations toward multilateral environmental conventions such as the United Nations Convention on Biological Diversity (CBD) and its Aichi targets, as well as adherence to the sustainable development goals (SDG's).

IAS strategy implementation requires good governance, which include development, application and enforcement of generally agreed rules. In IAS context, governance should consider developing a consultative and participatory mechanism to allow stakeholders, including community groups, active participation in the planning, implementation and follow up of IAS control measures and enhance their accessibility and stewardship over their natural resources.

Developing coordination and partnerships between MOENV and all relevant stakeholders on different IAS issues is a necessity. National Biodiversity Committee (NBC) resembles an excellent platform for encouraging stakeholders' participation in the control of IAS.

Strategic goals, objectives and activities are based on the following principles (figure 6):

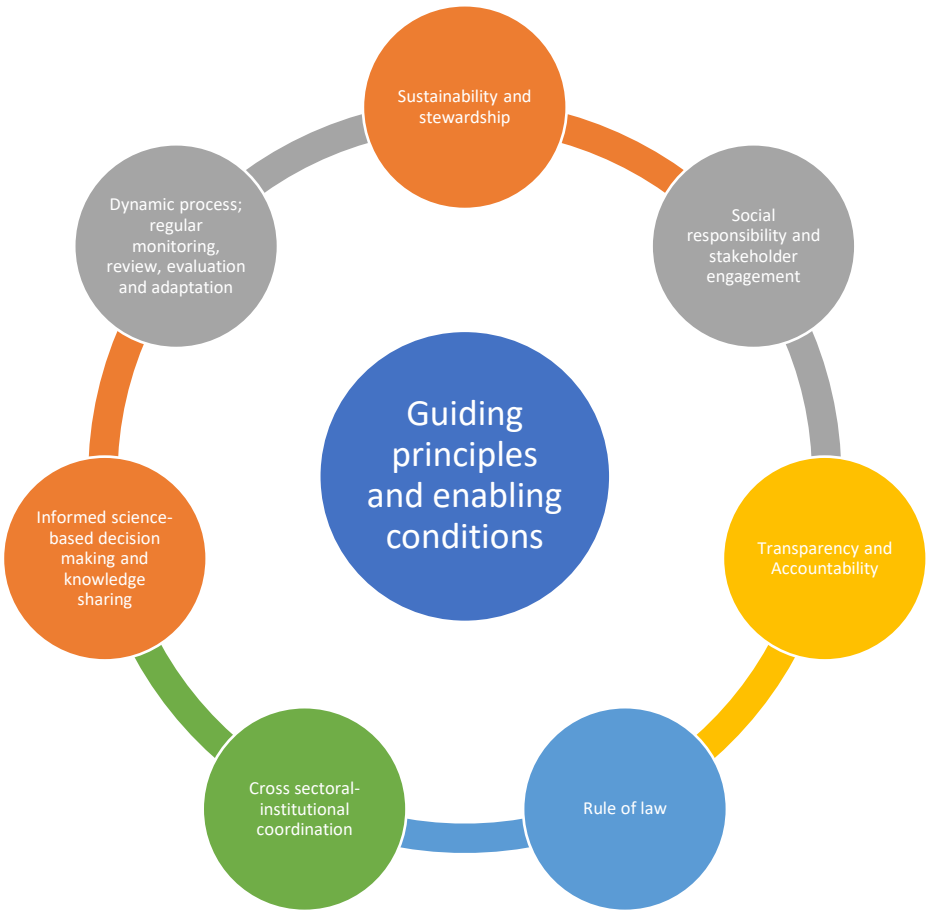


Figure 6: main guiding principles and enabling conditions for IAS strategy development and implementation.

1. **Sustainability and stewardship:** The strategic interventions have been developed to ensure the sustainability of targeted outputs. Local communities' rights to access healthy natural resources and benefiting from ecosystem services are essential to the implementation of this strategy and its provisions.
2. **Social responsibility and stakeholder engagement:** Controlling IAS is considered a cross-cutting issue, where it overlaps with different sectors and requires the involvement of multi-stakeholders groups. Therefore, stakeholders mapping is necessary to select the appropriate effective management practices at the national level.

3. **Transparency and Accountability:** The impact and extent of IAS effects on environment, social and economic aspects should be communicated in a transparent manner in order to apply effective measures and ensure the accountability of all stakeholders.
4. **Rule of law:** An active and well- enforced legal mechanism should be in place.
5. **Cross sectoral-institutional coordination:** Control of IAS requires well-coordinated efforts to develop and implement effective approaches and good practices. This would leverage available resources and ensure effective implementation of planned activities.
6. **Informed science-based decision making and knowledge sharing:** Solid science-based information is the tool to inform decision making process.
7. **Dynamic process; regular monitoring, review, evaluation and adaptation:** Strategy formulation and implementation is a dynamic process. Cycles of implementation, review and refinement will help in identifying challenges and adapt IAS strategy to the local context. Thus, improve possibilities for its successful implementation

4.2. Strategic pillars:

A situation analysis has been conducted to identify the strategic pillars required to control IAS, and these are: 1) knowledge management, 2) institutional arrangements and 3) resources and pilot initiatives. As the issue of IAS is multi-sectoral and include various taxonomic groups, key activities were indicated under each expected output. More detailed customized activities are indicated under individual thematic groups action plans (annex 1).

4.2.1. Informed decision-making process to control IAS improved

Lack of proper information regarding IAS in Jordan is due to the limited efforts conducted to understand these species and their impacts. Furthermore, Jordan suffers from lack of measures to control IAS and to stop further invasions. Therefore, gathering scientific information will support decision-making process and assist in developing appropriate proactive management plans. Priorities identification for solid scientific research form the basis for this component. Knowledge will also assist in developing adequate awareness raising programs to support IAS control efforts.

National Biodiversity Committee (NBC) should support the process of data transfer to decision makers and advocate for an efficient control of IAS in Jordan. However, the responsibility of IAS is distributed equally among various organizations and experts as well.

Main strategic outputs and key interventions under this pillar include:

4.2.1.1. Knowledge toward IAS status, potential impact and controlling measuress is strengthened, documented and disseminated at the national level

Key proposed activities:

1.1.1. Conduct baseline assessment including in-depth field inventories of main invading species and their actual or potential impacts on vulnerable natural ecosystems and ecosystem services.

1.1.2. Study and assess invasion impact on social dimensions including communities and community groups as well as the economical dimension associated with it.

1.1.3. Analyze and assess the current national capacities (technically, financially and regulatory) to control current and / or future invasion incidents.

1.1.4. Investigate potential shift in invasion process dynamics due to climate change projections.

1.1.5. Capitalize on the existing databases for effective knowledge documentation and sharing.

1.1.6. Document research findings and recommendations on best practices to manage IAS and share them with decision makers and other stakeholders.

4.2.1.2. Management plans developed, published and monitored on a regular base

Key activities:

1.2.1. Develop and implement adequate plans to monitor invasion occasions and their evolution in Jordan.

1.2.2. Establish an adequate monitoring and evaluation system to assess the plans developed and to evaluate IAS control effectiveness.

4.2.2. Stakeholders' competence, including experiences, know-how and skills toward IAS control is enhanced effectively

The second pillar of this strategy is to improve institutional arrangements and strengthen the available resources in order to ensure proper IAS control. The IAS affect various ecosystems, habitats, species and even communities and have the potential to affect diverse sectors. For that, competent institutions equipped with the required governance, resources and skills are required to collaborate and improve national preparedness to control the IAS species. Some aspects for improving institutional arrangements include:

Capacity development

The development of institutional capacities and their human resources are crucial to respond to multifaceted issues such as IAS. Thus, to develop different approaches and address different technical, social, economic, and environmental challenges raised due to IAS impacts. Capacity needs assessment is required to identify gaps and development needs. This will lead to the

development and implementation of elaborated plans for institutional and human capacities development.

Institutional coordination and collaboration

Responsibilities and roles of various institutions should be discussed and clearly defined. Coordination among relevant agencies and institutions to control IAS is crucial and requires efficient utilization of well-established mechanisms and developing other innovative approaches.

Developing coordination and partnerships between MOENV and all stakeholders on different IAS issues is a necessity. National Biodiversity Committee (NBC) resembles an excellent platform for encouraging stakeholders' participation to control IAS.

Efforts should also focus on regional and international cooperation programs to implement provisions of relevant agreements and tools to control cross border introduction and spread of IAS.

Legal arrangements:

To ensure adequate implementation of this strategy and its objectives, various legal measures should be taken into consideration. These include revising relevant norms and ensuring the harmonization of the current legal frameworks of different sectors and agencies with the propositions of this strategy. Thus, supporting its realization.

Clear legal guidance based on articles stated in MOENV legal framework, especially those in nature protection bylaw, provide required basis for developing relevant laws and regulations for various sectors. This will support strategy implementation and law enforcement as required by authorized agencies.

Financing mechanisms and arrangements

Conventional and innovative financial resources should be mobilized and sustained on the long run by developing strategic mix of all available financing resources. Thus, ensure effective control of IAS.

Promoting enabling conditions for implementing financial mechanisms such as creating incentives for private sector investments, disposal of communities to utilize IAS-derived benefits, and NGOs and CBO's engagement in IAS control, would be among the drivers to be strengthened.

4.2.2.1 Institutional setup and arrangements assessed and improved for better IAS control

Key activities:

2.1.1. Review and assess institutional capacities and framework with a special focus on the Ministry of Environment and Ministry of Agriculture, identify gaps and develop the required institutional framework.

2.1.2. Create practical and effective coordination means among relevant institutions and other stakeholders to control IAS and their impacts.

2.1.3. Review and develop the legal framework to enable responsible entities to enforce and implement laws to control the IAS effectively.

2.1.4. Support the government of Jordan to fulfil their obligations toward multilateral environmental convention in controlling IAS.

4.2.2.2. Adequate, sustainable coherent financing models mobilized and secured

Key activities:

2.2.1. Raise the awareness of strategic decision makers toward the negative effects of IAS at social, economic and ecological dimensions.

2.2.2. Study income generation opportunities created to the local communities by proper management of IAS.

2.2.3. Conduct cost-benefit and comparative analyses of alternative management options of IAS i.e. prevention compared to other management alternatives.

2.2.5. Develop a fundraising plan in order to mobilize international financing mechanisms to secure finance for developing and implementing national, regional and international cooperation plans to control IAS.

4.2.3. Priority IAS controlled, and their impacts alleviated to ensure better environmental, social and economic livelihoods

Pilot interventions are required to promptly respond to urgent and pressing impacts and challenges raised due to IAS. These include technical control of priority IAS ecological, social and economic impacts and utilization of potential IAS goods and services for livelihoods improvement. Pilots will also focus on developing IAS management frameworks for proper decision making, including plans, procedures and approaches to prevent future intentional or accidental introductions.

4.2.3.1. Outreach interventions are planned and implemented to alleviate IAS impacts at social and economic levels

Key activities:

3.1.1. Raise the awareness of local communities, public and other stakeholders regarding the negative effects of IAS on their social and economic perspectives.

3.1.3. Investigate community perception, knowledge and attitude toward IAS introduction taken gender into considerations.

4.2.3.2. Priority current and potential future invasion incidents are controlled, and their impacts reduced

Key activities:

3.2.1. Develop and implement integrated proactive management plan to control priority IAS for priority invaded areas / ecosystems and prevent any future intentional or accidental introduction of IAS.

3.2.4. Engage local communities, experts and relevant institutions in controlling IAS introduction, propagation and distribution by developing effective means and using advanced tools.

4.3. Monitoring strategy implementation, learning and adaptation

Monitoring, learning and adaptation is an integral part of IAS strategy and is crucial to assess planned activities implementation. This will assure collecting required data and providing feedback for assessing progress and identify challenges for strategy implementation in a timely manner. Cycles of monitoring progress, reviewing plans implementation and improving it will result in developing refined long-term plans adapted to national needs and challenges.

Monitoring, learning and adaptation should be conducted on a routine basis and, effectiveness of actions implemented should be evaluated on three-year interval to identify and understand implementation challenges and opportunities, and to adapt them to newly developed action plans. The whole document including its strategic goals should be reviewed every five years to ensure its harmony with national priorities and international orientations including sustainable development goals and provisions of CBD.

MOENV will be the national umbrella to guide M&E process and should facilitate this process in coordination with national stakeholders, who will be conducting these assignments, and provide MOENV with progress reports to be assessed and compiled. NBC also plays an important role in this process, where it can provide support and guidance to MOENV and other stakeholders.

5. Annexes