B2. Scientific and technical description of the project

B2.1. Scientific proposal

The INDALO project aims to study biodiversity in different representative ecosystems of Andalusia, and analyze its evolution to detect and understand the consequences of Global Change (which includes Climate Change, Demographic changes, Productive, Land Uses natural resources).

For this purpose, it will make available to researchers, those tools, monitoring equipment and networks, and the technology necessary for the development of scientific tasks.
All this will be provided in a common work environment where both managers and scientists can use and share information, favoring the transfer of knowledge generated to improve the management of biodiversity by the Andalusian Administration.

The information, data and results generated will be standardized according to the standards defined by LifeWatch ERIC, allowing the exchange of information, providing support to the ERIC and complying with the terms of the Agreement signed in 2016 for the participation of Andalusia in LW.

To carry it out, a platform will be established on a scientific-technological infrastructure that will act as an operational framework and integrator of the work of scientists in their analysis, evaluation and forecasting of the impact of Global Change on biodiversity and on Services provided by ecosystems. to society, with the aim of generating useful knowledge to improve the management of biodiversity.

This platform will have two purposes:

- The generation of knowledge about biodiversity by research centers and its transfer to the administration for its application in management, decision-making and public policies.
- The integration into Lifewatch, to which it will contribute a flow of data generated in the system, with specialized software and, when appropriate, providing the necessary computing capacity, in accordance with technical and regulatory standards.

Technological Purpose: Architecture of INDALO

The INDALO project represents an advance in this regard by enabling an organized technological structure that connects the entire Andalusian scientific community that investigates Global Change (from any line of research).

Enables a work environment in which the data captured by the measurement networks deployed in Andalusia, of any variable, will be included in the system and will be organized and documented in a single environment to which any interested researcher can directly access, or any technician belonging to any Administration that manages these resources

The technological proposal of the INDALO project is presented at four major levels:

a) Acquisition of Data;
b) Storage;
c) Generation of Services
d) Exploitation

Data acquisition

The integration of different data sources is key in LW and therefore it is in INDALO, which will focus on 4 data sources:

1. One of the main sources of information will be REDIAM, whose databases will include a review and selection of the contents of interest.
2. Another of the great data sources comes from the Regional Biodiversity Observation and Global Change Networks that measure general environmental parameters. They depend on the CAGPDS, cover the entire Andalusian territory, and must be appropriately densified to allow obtaining basic information that fulfills the purpose of LW.
3. INDALO will also enable citizen science initiatives solutions for data capture.
4. Finally, the data obtained by the Local Networks, attached to specific ecosystems (mostly dependent on the TCEs supervised by the Universities and Research Centers) will be integrated.

Storage

All these data sources must be connected in a single data repository in the Hub Node.
This allows the harvesting of the data produced and its correct storage - with the appropriate organization and documentation to guarantee its location, accessibility and persistence, also always safeguarding its interoperability and reuse.

Generation of Services

The access and exploitation of the data within the Hub Node should be guaranteed by developing services that treat the information and serve it in the most appropriate way depending on the needs that they have to cover, whether for management, research at the level local or internationalizing it to be used through the Lifewatch network.

Exploitation

The system allows enabling virtual research environments in which to work with any type of data or service that exists in the Hub Node, and allowing the transfer of knowledge or the development of collaborative works between different research groups using common tools. In addition, the system should allow generating aggregate information for its use in the analysis and management of resources and territory.
INDALO proposes a modern ICT infrastructure, which will launch a technical e-Infrastructure support that will be federated to LifeWatch ERIC through its ICT Core, to allow a large volume of data to flow and thus contribute to the capitalization of knowledge.

In addition, it will allow connecting and transfer data to the Spanish Inventory of the Natural Heritage of Biodiversity (IEPNB) as well as to scientific bodies such as the CSIC and other international initiatives.

In the case of the CSIC, the connection with the ICTS-RBD will be established in order to align this technological infrastructure with the Lifewatch ERIC standards, and allow the flow of data and exchange of information with this organisms through the INDALO project.

INDALO guarantees the development of the necessary tasks to comply with the technical requirements and necessary standards defined by the ICT Core of LifeWatch ERIC for the integration of information and to guarantee the connection with other distributed e-Infrastructures.

The huge volume of environmental data that will circulate should be adapted to the formats and standards that allow working and analyzing the information in the so-called "virtual research environments" or "virtual laboratories", which should be used by the European

scientific community, starting with the Andalusian System of Knowledge, based on the priorities of the current PAIDI.

The Data Infrastructure in which the information will reside will integrate an ample set of resources (documented data, catalogs to facilitate the searches of the services, computers-servers, computer programs and applications, web viewers, ...), all of them dedicated to manage the information produced, complying with interoperable data guidelines, a fact that is achieved through computer processes adjusted to standards, specifications, protocols and interfaces.

The architecture of the INDALO infrastructure will be constituted by the following elements:

1. Hub Node
2. Regional Networks for the Observation of Global Change
3. Local Networks of Observation of Global Change
4. Peripheral Local Nodes
5. Communications between nodes

The constituent elements of the aforementioned architecture are described schematically and conceptually below.
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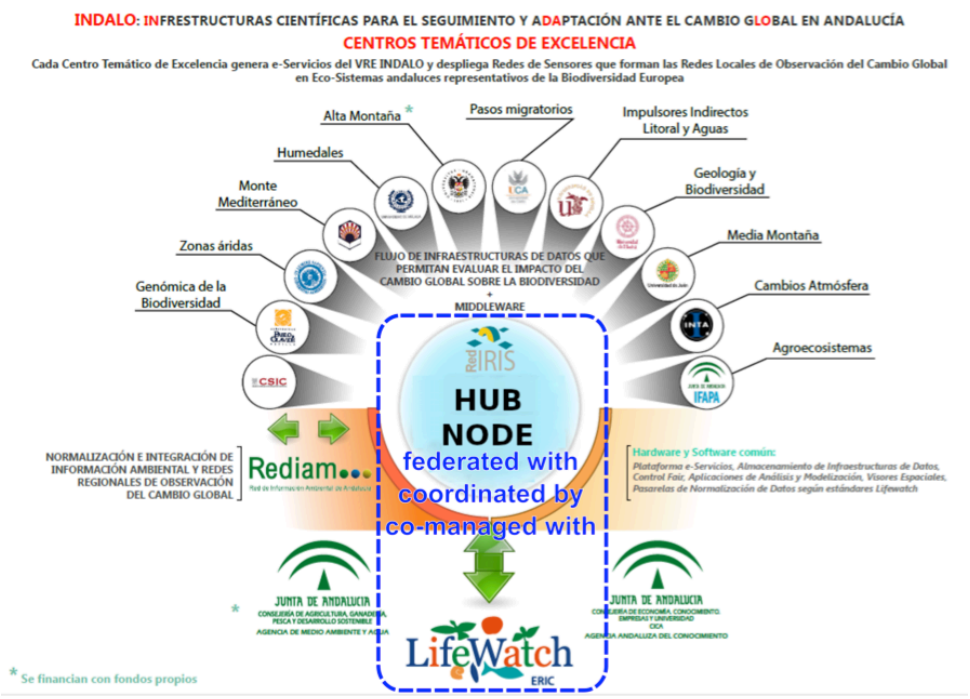


1. Hub Node federated with LifeWatch ERIC

The Hub Node will collect and dispose of the information coming from the peripheral local nodes (of the Observatories of Global Change) as well as the information of interest available in the REDIAM and the Regional Networks of Observation of the Global Change operative.

It will serve as a support platform for:

- The scientific works
- The subsequent I + D + i
- The translation of science and innovation to sectoral and territorial management

It will develop a key task of information exchange, fundamental in the Transfer of Knowledge, between the scientific field and the areas of management (Administrations, for the development of effective policies) and production and services (transfer to Companies, the Third Sector and the citizenship).

For this purpose, this e-infrastructure will proceed to:

1) The collection of data from the Global Change Observation Networks in Andalusia.
2) The exchange of information between the Thematic Centres of Excellence (generators of Science and Innovation) and:
    a. The Scope of Management (mainly CAGPDS), in a scheme replicable by any Region of the EU that joins LifeWatch.
    b. The productive fabric (business activities)
    c. The Third Sector (NGOs linked to the Defence and Observation of the Environment), and with the general public.

To guarantee independence, it will be based preferentially on free software and open standards.
To guarantee efficiency, mechanisms will be defined that allow the information captured by the sensor networks to be derived directly to the Hub Node, for its subsequent dissemination to the research community.
In the section of Work Package 1, it is explained in more detail.

2. Regional Networks for Global Change Observation

The regional sensor networks for the study and monitoring of the operational and available biodiversity in REDIAM cover all of Andalusia since 2000.
They provide basic knowledge on how natural and human systems evolve, and the impact of their changes as well as on policies and management measures.

INDALO proposes the adaptation and communication with the Hub Node and the TCEs of the following networks (see WP2 for more detail):

Mediterranean Forest Ecosystems (& Mid mountain)

1) Network of Automatic and Remote Meteorological Stations
25 automatic meteorological stations managed systematically by the Provincial Operational Center of the Fire Fighting Plan (Infoca)

2) PINSAPO first level network
It allows to establish an annual image of the state of the trees, determine trends, detect anomalous situations and identify relationships between environmental variables.

3) SEDA First Level Network
It develops an annual evaluation of the state of the Andalusian forest vegetation and the effect of environmental variations on it. Performs a sampling of more than 400 points and 8000 trees to estimate foliation, discoloration, identify harmful agents and quantify their effects.

4) Land-birds monitoring network
A technical team distributed throughout the Andalusian territory that assesses the trends of winter breeding populations of land-birds, taken as indicators of the impact of Global Change on biodiversity (displacement of distribution areas due to changes in the configuration of habitats, changes in the state of conservation or in the protection of the territory.

5) Imperial Eagle tracking network
A technical team that carries out the census, monitoring and management recommendations for the conservation of imperial eagle populations.
Evaluates trends of the breeding population with the same purpose and methods as in the previous network).

6) Network of monitoring of migratory BIRDS of hunting interest
Record the contacts produced of any of the species under study: species, number of individuals, age class, sex, geographical coordinates, date and time of contact.

7) Tracking network of predators and small carnivores
Track tracking and identification of the predatory species that generate them, through technologies such as thermal imaging and drones

8) Hunting wildlife monitoring network
Sampling based on Distance Sampling methodology: identification of specimens, location with a mobile phone, and immediate delivery to a central server.
Subsequent statistical analyzes study distribution, density and dispersion.

9) Drones Monitoring network for threatened species
Drones improve the scope of tracking and allow new parameters to be obtained
Tracking of fauna included in Plans for recovery and conservation of threatened species in Andalusia and their habitats.

High Mountain Ecosystems

10) Sierra Nevada Natural-National Park Network
3 automatic meteorological stations (of the nearly 1000 that REDIAM has), equipped with gas exchange measurement sensors and climatological variables such as precipitation, temperature, humidity or wind.

Rivers and Banks Ecosystems

11) SAIH Hidrosur
Network of remote stations to obtain real time information on hydro-meteorological incidents (water levels, flow rates, rainfall, weather, weather stations). The objective is the analysis of Climate Change and its direct effects (forecast of floods, availability of water resources).

12) Groundwater Quality Control Network

360 control stations that carry out physical-chemical sampling to evaluate chemical status of groundwater bodies, to warn of potential contamination, evaluate compliance with current regulations and assess the effectiveness of control measures and reduction of pollution.

13) Piezometry Control Network:
406 sensors placed in boreholes and wells that evaluate the groundwater level of groundwater bodies: water balances, recharge and other indicators.

14) Automatic Water Emission Network
Network of sensors arranged at the outlet of the effluents of the most important urban wastewater treatment plants. They measure pH, conductivity, suspended solids, oils and fats, to verify compliance with the Spillage Regulations.

15) Network of meteorological stations of the Guadalfeo Project
4 automatic meteorological stations that analyze the dynamics of the Guadalfeo river basin.

Lakes, wetlands Ecosystems

16) Surface Water Quality Monitoring Program. DMA application
435 control points where physical-chemical, biological and morphological samplings are made that characterize the final state of the continental, transitional and coastal water masses in relation to pollution. Evaluate the health of aquatic ecosystems.

17) Network of Meteorological Stations of AMAYA
Measures parameters of precipitation, maximum temperature and daily minimum temperature for monitoring the climate in the Intra-Community Basins of Andalusia

Reservoirs Ecosystems

18) Rivers gauges Network
Devices with different technologies (radar ...) to register levels and flows of rivers, reservoirs and channels, for decision making in the management of floods, ecological flows, water quality and risk analysis in dams.

Coastal and marine Ecosystems

19) Automatic Water Inmission Network
Network of Sensors in the Andalusian Coast and the area of tidal influence of the Guadalquivir River that measure pH, conductivity, oxygen in suspension and temperature among others to know the pollution levels.

20) Coastal waters microalgae monitoring network
It measures the tropicalization of the Mediterranean Sea: temperature conditions, nutrient increase due to eutrophication, the presence of exotic thermo-resistant species and the disappearance of native species.

21) Endangered marine invertebrate and seagrass monitoring network
A technical team of divers It monitors the main pressures and threats suffered by 9 species included in the Plan for the recovery and conservation of species and their habitats along the Andalusian coast.

22) Monitoring network of cetaceans and sea turtles in the Andalusian coasts

Emergency network that monitors sea turtle nesting and studies the causes of death by stranding. It acts in the recovery and return to the marine environment of stranded cetaceans, and studies the incidence of pressures and threats linked to Global Change on these species.

Agro-Ecosystems

23) Alert Network and Phytosanitary Information
Pest monitoring and detection
100 automatic weather stations that measure parameters related to temperature, relative humidity, precipitation, average wind speed, mean wind direction, average speed, direction of the maximum streak and solar radiation.
Operated by the Ministry and the Ministry of Agriculture, its objective is to detect and control pests, especially the olive fly.

24) Agroclimatic Information Network
IFAPA network with 100 automatic weather stations to inform farmers about the water needs for crops.

Aerial ecosystems

25) Network of diffusive collectors in nuclei of more than 50,000 inhabitants
They measure the concentration of atmospheric pollutants in medium-sized cities that do not have an automatic station of the Surveillance Network.

26) Background Network of Diffusive Sensors
It determines the concentration of pollutants in the rural bottom, in locations sufficiently far from the polluting emission zones.

27) Modeling network of Air Quality in Andalusia
Modeling network in Andalusia that allows to anticipate the concentration levels of expected pollutants from the predicted emissions and the weather forecast.

28) Automatic Inmission Network
Surveillance and Air Quality Control Network that captures ten-minute values throughout the Andalusian territory that are key to the annual evaluation and to follow strategies and plans

29) Air Quality Monitoring and Surveillance Network: Meteorological Stations
Network of meteorological sensors that measure temperature, relative humidity, precipitation, average wind speed, average wind direction, atmospheric pressure and solar radiation.

30) Stratospheric ozone measurement network
Observatories global network, one of which is in Andalusia, in the Atmospheric Sounding Station of El Arenosillo (Huelva), under the INTA (National Institute of Aerospace Technology), which monitors the thickness of the ozone layer and the ultraviolet radiation.

31) Andalusian Network of Measurement of the Ultraviolet Index
INTA network of 4 sensors distributed by western Andalusia for the monitoring and prediction of ultraviolet index values and which with INDALO would be extended to Eastern Andalusia (under the ownership of the CAGPDS).

32) Andalusian Aerobiology Network
Network of 8 sensors of the CSGPDS located in each of the Andalusian provincial capitals for monitoring and prediction of pollen levels by different Andalusian universities coordinated by the University of Córdoba.

33) Network of the State Meteorological Agency
It is composed of four types of networks, Network EMA (automatic stations), Network of Main Stations, Network of Secondary Stations and SYNOP Network (civil and military airports). Its purpose is weather forecasting and climate monitoring.

34) In-situ measurement network of the radiative forcing of atmospheric particles. Monitoring of the influence of atmospheric particles on the surface in solar radiation and terrestrial energy balance. It is made up of several observatories distributed all over the world, one of which is in the Atmospheric Sounding Station of El Arenosillo (Mazagón, Huelva), dependent on the National Institute of Aerospace Technology.

35) Column measuring network for the radiative forcing of atmospheric particles. Monitoring of the influence of atmospheric particles on the entire atmospheric column on solar radiation and terrestrial energy balance. It is made up of several observatories distributed all over the world, one of which is in the Atmospheric Sounding Station of El Arenosillo (Mazagón, Huelva), dependent on the National Institute of Aerospace Technology.

3. Local Networks of Observation of Global Change

They are Local Networks distributed in the main ecosystems of Andalusia by the so-called TCEs. The implementation of new local networks, as well as the improvement of existing ones, are detailed in WP3.

4. Peripheral Local Nodes

The peripheral local nodes correspond to the infrastructure of each of the TCEs. These nodes, which will have their own operation and data management systems, will be adapted to allow connection with the Hub Node for the transfer of data to it.

5. Communications between nodes

Peripheral local nodes will make their data available to the external data import subsystem of the Hub Node, through a middleware composed of ETL systems and standards-based services (LTER controlled vocabulary, PML, EML, DwC) that will be provided by these peripheral nodes.

Scientific Purpose

The scientific purpose of the project is to advance in the study of biodiversity and how it is affected by Global Change in a border territory such as Andalusia, taking the evolution of these ecosystems as an indicator of the Global Change process.
To this end, it will be developed in all the representative ecosystems of the region, not only in the Protected Natural Spaces, a Network of Observatories for monitoring Global Change that will monitor the effects of Global Change in the short, medium and long term and will contribute to the scientific community large data sets.

Each one of these observatories will be formed as a Thematic Center of Excellence (hereinafter CTE) in the ecosystems under study. They will use the INDALO platform as a basis for a distributed work environment, where they can capture, normalize, analyze and share information.
The TCEs will develop the following studies within the framework of INDALO:

1. Anticipate and mitigate the effects of Global Change in the Agro-ecosystems on which the survival of the human being directly depends

It will be led by IFAPA, which will carry out the characterization and monitoring of the natural and cultivated biodiversity of the agro-ecosystems to assess from three territorial scales (plot, agricultural exploitation and district) the behavior of these ecosystems in relation to biodiversity, and its behavior in the face of Global Change, and specifically in the face of expected changes in climate (droughts, increase in temperatures, etc.).

The ecosystems modified by man for agricultural production, and the biodiversity present in them, have great territorial importance in the Mediterranean and European areas.
Andalusia due to its geographic location and current and future climatic conditions presents a great interest for studies related to biodiversity and Global Change. Given the great diversity of the Andalusian territory it is necessary to establish different observatories in the different Andalusian agroecosystems in order to carry out an integral analysis of the behavior of their biodiversity.

2. Observation of biodiversity indicators to develop warning systems for alterations caused by Global Change

The Universities of Córdoba & Jaén will observe the influence of Global Change, especially Climate Change, on the biodiversity of the Mediterranean Forest & Mid Mountain ecosystems with the purpose of developing sustainable management tools that guarantee the environmental, social and economic viability of these ecosystems in Sierra Morena and the Sub-Betic Sierras.
Will generate information that simulates the functioning of ecosystems at different spatial and temporal scales and provide potentially useful information for other observatories and monitoring networks at national and international levels.

The Sierra Morena observatory aims to expand the information already offered by other sensor networks like IFN or Red SEDA, coordinating this infrastructure with existing ones.
The Observatory of Global Change of Sub-Betic Sierras (OCGSS), meanwhile, will deploy a high density stations network, high temporal and long-term resolution to monitor the diversity of species, their habitats, their functions and services ecosystems and the environmental factors that affect them. The OCGSS would provide a change alert system and a laboratory to understand the mechanisms of change and the design of adaptation actions

It is hoped that this network will attract researchers from the LifeWatch thematic area to carry out their research projects in the territorial framework of the OCGSS. The Sub-Betic Sierras have a high concentration of species and habitats in a good state of conservation despite the fact that they withstand strong anthropic pressure, in addition to the risks associated with climate change, which endanger the conservation of biodiversity even in enclaves that have received less human impact.

3. Monitoring, analysis and dissemination of Global Change in human activities and land uses, and vice versa: human action as an agent of Global Change

Led by the University of Seville, quantitative and qualitative data of the indirect drivers of Global Change (demographic, economic, socio-cultural processes) will be collected and their effects on environmental and territorial sustainability and on Eco-Systemic Services will be analyzed. The results of governance will be interpreted in the monitoring and cushioning of these impacts, as well as the degree of knowledge and awareness of society.

They will develop:

- A web platform will allow spatial integration in a multiscale grid of all the aforementioned variables as well as the calculation of impact and vulnerability indicators in coastal ecosystems
- Computer tools to access the monitoring data on the spatial variables of anthropic action and their effects on coastal ecosystems (population, residential space, infrastructures ...).

4. Wetlands and Surface Waters: Indicators capable of anticipating the effects of Global Change & developing policies that guarantee the key resource of human survival

It is estimated that Global Change will generate in the short term an increase in pollutants in water bodies, especially in the areas most affected by human activities (mining, fishing, agriculture - nitrate filtration - and industry).

In order to simulate future scenarios, the University of Málaga will conduct a hydrogeological and satellite monitoring of wetlands to accurately know their water performance and quantify the elements (including groundwater) that intervene in their balance.

The University of Seville, in collaboration with INTA, will monitor the physic-chemical and biotic variables in the water column that influence biodiversity of 6 reservoirs which are indicators of great precision on the effects of Global Change.
Likewise, IFAPA will continue to follow oceanographic variables in the Guadalquivir estuary in terms of Biodiversity, Trophic Structure, Ecosystem Functioning and its impact on Fisheries.

The University of Huelva will carry out a predictive model that will be supported and contrasted with high-resolution hydrological and hydrochemical data from the Tinto river basin that can be viewed online by the citizen.

5. Atmospheric analysis at different scales to anticipate weather patterns and their impacts on flora and human health

The modification of climatic patterns and the increase of chemical species harmful to the environment are key factors in the loss of biodiversity.

To enhance conservation, mitigation and adaptation policies, INTA (as land-air Observatory) will analyze the atmospheric composition (particles and trace gases) and solar radiation, through systematic observations of high quality with unconventional techniques, and evaluate their potential effects on biodiversity.

The University of Huelva, supported by the Andalusian Aerobiology Network (RAA), will study the concentration of pollen and spores in the atmosphere, to determine the impact of climate change on the flora, ecosystems' dynamics, and on public health (allergies).

6. Study of biodiversity from the perspective and techniques of genomic analysis as support from a differentiated approach to observation by sensors

The monitoring of biodiversity in ecosystems using sensors is subject to observations and sampling that is difficult to automate, often requiring the observation of complete individuals or at a time in their life cycle.

The proposal of the Pablo de Olavide University lies in obtaining and analyzing the DNA present in an ecosystem as a formula to systematize the detection of biodiversity in a non-invasive way, monitoring species that are difficult to sample and even species not described.

7. Monitoring of marine and Coastal terrestrial biodiversity

Led by the University of Cádiz, the Observatory of Biodiversity in the Strait of Gibraltar aims to monitor long-term biodiversity in this unique enclave, allowing the collection of spatial information and time series of key elements of marine biodiversity and land.

The Strait of Gibraltar is one of the main hot spots for biodiversity worldwide, being one of the areas that concentrates a greater number of endangered or endemic species, and concentrating millions of organisms both marine and terrestrial during their migrations, to the point of confluence of the Mediterranean Sea and the Atlantic Ocean and of two continents (Europe and Africa).

8. Monitoring of water cycles, carbon and CO2 emissions of vegetation in arid and semi-arid ecosystems

Led by the University of Almería, from the Arid Zones Observatory, it is proposed to generate and provide continuous data to answer scientific and management questions related to the impact of climate change and changes in land use.

It will also provide information on the functioning of arid ecosystems at different spatial and temporal scales, with emphasis on the role of biodiversity in the carbon and water cycles, and on the impact of Global Change on them.

9. Global Change Monitoring in the High Mountain Ecosystem

The Agreement between CAGPDS and the University of Granada for the development of activities linked to the Sierra Nevada Global Change Observatory (unique for its latitude and closeness to the sea), states that the information and the results generated will be contributed to the data repository of the Ministry through its integration in REDIAM.
These will be the two ways for which this University will participate in INDALO, although the University will not be a recipient of funds.
The following lines of research are being developed:

- Sectorial analysis of the impact of Global Change, with support from the LINARIA Information System (integrated in REDIAM)
- Study and modelling of key ecological processes for the provision of ecosystem services.
- Design of adaptation strategies and mitigation of Climate Change.

WORKPLAN

In order to carry out this deployment and to allow a standardized information flow, a Work Plan has been defined that allows reproducing the ERIC LIFEWATCH guidelines regarding HW-SW infrastructures and information flows, while defining the Work coherent with the purpose of the Call, with the terms of execution and with the available budget.
In summary, the Work Plan consists of 6 Work Packages:

1. WP1: VRE INDALO: Infrastructure HW and Architecture SW
2. WP2: Adaptation of Regional Networks for the Observation of Global Change
3. WP3: TCEs linked to ecosystems (Local Networks of Observation of Global Change)
4. WP4: Infrastructure for integrating information. Coordination of data management
5. WP5: Communication, dissemination and connection with other international infrastructures
6. WP6: Operational, Administrative and Budgetary Coordination

The tasks to be developed and products to be obtained will be structured as follows:

- Consultancy work for the design and operation of infrastructure
  - analysis and prospecting of needs, technological prospective to select the best solution, storage architecture, processing and sensor networks, adaptation of pre-existing elements, start-up support, etc ...)
- Acquisition, installation, configuration and commissioning of software elements necessary for the operation of hardware elements in the form of virtual research environments.

Likewise, the communication infrastructure must support the information flows of the different sensor networks distributed throughout the territory and producers of environmental data.

New automatic sensor networks will be created, with real-time data transmission, that capture data distributed in the territory of environmental elements relevant to the study of biodiversity and ecosystems (climate, air, water, flora, fauna, soil, etc.). ...)

It also contemplates the modernization, adaptation and geographical densification of existing sensor networks, which currently collect data for environmental management purposes and that need to be transformed to be useful in the field of scientific research on biodiversity and ecosystems.

The work plan is organized into work packages (WP) that are described below:

WP1: VRE INDALO: Infrastructure HW and Architecture SW

It includes tasks for the design and implementation of a specific software architecture and information exchange services between the nodes and from the nodes to the scientific community, allowing convenient and efficient access and exploitation of the data.
Preferably it will be developed in free software, and will be adapted to the functional needs of each node. In the Hub Node, there will be a platform that provides at least:

- Services and web portals; Relational and non-relational database managers; Geo-referenced databases managers; Geographic information analysis systems (GIS); IDE nodes; Portals to disseminate results beyond the technical and research scope; Information consultation systems (viewers); and Virtual desktops and virtual laboratories

The infrastructure will be designed with the aim of facilitating the management of virtual laboratories when defining and deploying sets of predefined applications and data on which to operate. It will also provide the information structure converters necessary for the exchange of information with other data banks such as the Spanish Inventory of Natural Heritage and Biodiversity.

- 'Virtual laboratory' means an environment that uses ICT to provide its users with different scientific tools for consultation, analysis and data processing, plus a set of data available on which to carry out these activities and solutions for the accomplishment of works in a collaborative way promoting the exchange of methodologies and results between different work groups.

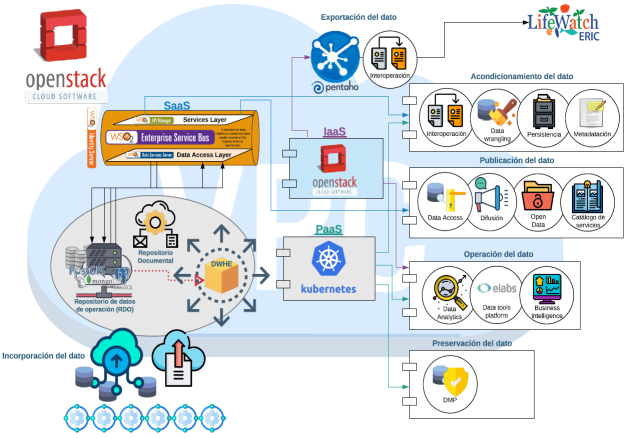
The software platform of the infrastructure will ensure high availability, scalability and flexibility, to adapt to the changing and predictably growing needs of users, and to support mass calculation processes in High Performance Computing (HPC).
Each one of the TCEs, acting as peripheral local nodes, will connect to the Hub Node, for the collection and initial treatment of the data captured by their own sensor networks, deployed in the specific ecosystem object of their studies.

Due to its heterogeneity, the needs of each Thematic Center of Excellence will vary depending on the existing staffing in each one of them at present, and the volume of data and the complexity of the processes that apply to them.

The support to the legal aspects associated with the decision making process derived from the use of the VREs themselves will be guaranteed by the LifeWatch Blockchain platform (LifeBlock), a highly secure distributed system with interoperability capabilities to track information without the need for a centralized system.
To ensure the system's resilience to cyber attacks, the perimeter security mechanisms (appliances, services, procedures) established by LifeWatch ICT Core will be compulsory incorporated, both at the level of network protocols and at the level of application protocols.

Hub Node federated with Lifewatch ERIC

The Hub Node will collect, store, manage and preserve the structured and documentary information coming from the nodes of the different Local Networks of Observation of Global Change as well as the Regional Networks of Observation of Global Change in Andalusia and the Observation Networks deployed by the TCEs in their Ecosystems.



The HUB will be implemented on the basis of the existing technological infrastructure (hardware and software) of the REDIAM after being duly adapted to LifeWatch ERIC ICT Core standards. To that purpose, a MIDDLEWARE e-Infrastructure duly engaged with the LifeWatch ERIC ICT Core (through LifeBlock) will be also established.

The hub is conceived as a private cloud infrastructure based on the paradigm "Everything as a Service" (XaaS), to offer software (SaaS), platform (PaaS) and infrastructure (IaaS) services; supported by a data infrastructure that would have a documentary repository, a subsystem for the storage of structured data or Repository of operation data (RDO) and another for the persistence and management of aggregated data or data warehouse ((DWHE) .

The entire software services catalog will rest on a Business Services Bus (ESB) that would provide access to the canonical data model hosted in the RDO.
The data model will be designed to house all data from observation networks in a single database and will serve as a reference for all entities and their relationships by collecting all the descriptive elements of each stored data (metadata at the data level). This model will be oriented to scientific use by harmonizing all the collected data so that they can relate to each other.

The ESB will be the component responsible for communication with the data infrastructure of the Operation Data Repository.
The data subsystem will only maintain a direct connection between RDO and DWHE through ETL type connectors that will feed the data store incrementally and periodically from the Data of the Operation Data Repository.

In the DWHE, aggregate data will be collected to facilitate analysis and exploitation for management. This data will be aggregated into datasets (datasets) that will be described and identified by descriptive tabs (metadata at the dataset level).
The rest of the necessary communication will be the responsibility of the middleware layer (ESB).

In the same way, the entire provision of software services for authorized corporate and external applications will be supplied through the service layer module of this infrastructure.
The RDO component of the data subsystem is eclectic and can group several database management engines, SQL and non-SQL, thanks to the abstraction provided by the Data Services layer of the ESB.

The native GIS operation will be searched in the engine that hosts the spatial data set and the secured connection between the different elements via ESB.
The component for document storage will comply with the CMIS standard and provide a scalable and highly available document lifecycle management solution.

The infrastructure software platform will ensure high availability, scalability and flexibility, (to adapt to the node's service delivery commitments, the changing and predictably growing needs of users), support mass calculation processes in High Performance Computing (HPC) and independence to be based preferably on free software and standards.

In the Hub Node there will be a platform that provides at least services and web portals, relational database managers, georeferenced database managers, geographic information analysis systems (GIS), IDE nodes, portals to disseminate information to the results outside the technical and investigative scope, based on open, standardized and accessible formats both by people and by automated systems, information consulting systems (viewers) and virtual laboratories.

It is understood by 'virtual laboratory' an environment that uses ICT to provide its users with different scientific tools for consultation, analysis and data processing, plus a set of data available on which to carry out these activities and solutions for the performance of collaborative work promoting the exchange of methodologies and results between different work groups.

The infrastructure will be designed with the aim of facilitating the management of virtual laboratories when defining and deploying sets of predefined applications and data on which to operate. It will also provide the information structure converters necessary for the exchange of information with other data banks such as the Spanish Inventory of Natural Heritage and Biodiversity.

The external data import subsystem will be designed to incrementally load, periodically and at will, the data that the local peripheral nodes make available to the Hub Node, through ETL systems and standards-based services (LTER controlled vocabulary, PML, EML, DwC) provided. by these peripheral nodes.

The Hub Node will also provide citizen science services aimed at encouraging citizen participation in the generation of information.

The data export subsystem to Lifewatch ERIC must make use of an interoperation service to generate an incremental data set with controlled vocabulary, based on standards and compatible with the requirements of Lifewatch ERIC.

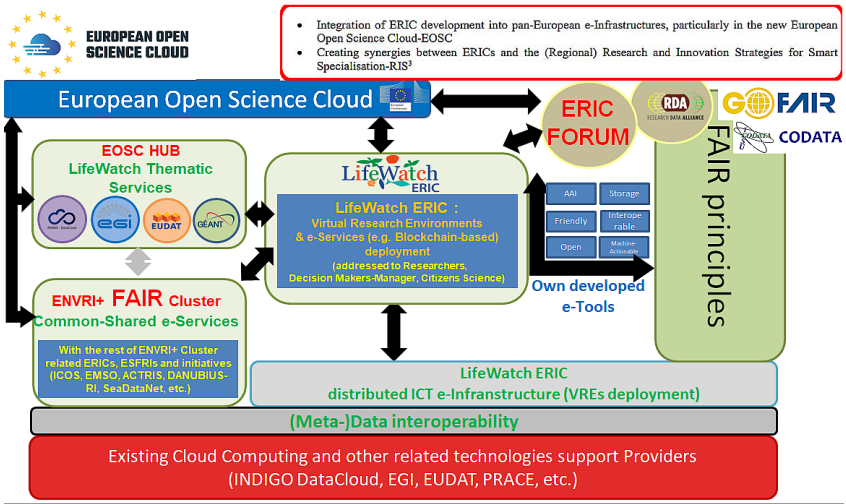
All the necessary tasks will be carried out to ensure the correct adaptation and fulfillment of the integration requirements of the developments in the ICT Core of LifeWatch ERIC, in order to guarantee the connection with distributed e-Infrastructures and other pan-European technological initiatives.

Likewise, collaborative tasks will be established with another or other international initiatives of recognized interest to LifeWatch ERIC, such as other ERIC, GBIF, IPBES, IUCN, BIODIVERSA, IBERLIFE-IBERGRID, EU-CELAC RI, PRIMA, AIR Center, CLRTAP, GEOSS-GEO BON, JRC, NEON and Climate KIC-EIT.
When necessary, we will have the participation of experts with experience in the implementation of this type of infrastructure of interest to LifeWatch-ERIC.

Integration in the ICT-Core

INDALO VRE will be properly integrated in the ICT-Core e-Infrastructure coordinated and managed by LifeWatch ERIC.
LifeWatch ERIC ICT Core acts as the coordinating umbrella to manage and operate its distributed computing infrastructures at panEuropean level. Taking advantage of IBERGRID know-how in federating computing and data infrastructures regionally distributed, we conveniently use such federated resources at IBERLIFE (Common LifeWatch Portugal-Spain initiative) level.
This will allow to integrate and federate LifeWatch ERIC developments into the European Open Science Cloud (EOSC) through: EOSC-synergy ,ENVRI+ FAIR Cluster, EOSC-Hub & ERIC Forum. Copernicus data and developments will be also integrated.

All of these, coordinated by the LifeWatch ERIC ICT Core Working Team as stated in the ERDF call for proposals that this project is applying to.



ERIC in the context of the European Open Science Cloud -EOSC

Among other essential activities to be performed in tightly collaboration between the project beneficiary and the LifeWatch ERIC ICT Core Working Team there will be:
1) Support to the federation of the Lifewatch-ERIC distributed e-infrastructure and integration into the EOSC in relation to Federated Authorization and Authentication using OpenID-connect technology; Monitoring and Accounting services; Support to the deployment of Lifewatch ICT core services; Designing of failover mechanisms to support redundancy of critical services; Orchestrating services to access hybrid infrastructures; Supporting the integration of ICT Core services in the EOSC landscape.
2) Support to Lifewatch-ERIC Networking activities like Lifewatch training program for both software developers, resource administrators, biodiversity service integrators, and end users; Infrastructural support for tutorials and training events & Support to dissemination activities in the EOSC framework via the activities of ICT Core, by developing a joint dissemination program.
3) Support to applications integration and user engineering in Lifewatch-ERIC Virtual Laboratories, e.g.: Support to the full integration of Virtual Laboratories, from PaaS to IaaS

level, including orchestration capabilities; Support to the deployment of the Virtual Labs at the infrastructure level (Infrastructure Manager -IM); Support to event-driven technology integration using serverless technologies (OSCAR); Support to the usage of containers in HTC and HPC infrastructures (udocker); PaaS support to compose and orchestrate Machine Learning processes, to support the usage of Blockchain (LifeBlock), Big Data, Deep Learning & AI techniques in Biodiversity; Support to the deployment of demonstrative and learning-assisting interfaces, such as Jupyter notebooks, on the ICT Core Services.

SaaS by integrating the different applications and services developed in this project.

WP2: Adaptation of Regional Networks for the Observation of Global Change

INDALO will proceed with the operational deployment of two sensor networks that will capture information on the different Andalusian ecosystems:

- A System of Sectoral Observation Networks of Local scope, specifically designed and implemented for the study of Ecosystems from the TCEs, and which are addressed in WP3.
- Regional Networks for the Observation of Global Change, deployed and operated by REDIAM for 20 years to study Risks for Biodiversity associated with Global Change.

These transversal networks represent a fundamental element of the monitoring system proposed in this proposal. They provide basic knowledge about how natural and human systems are evolving, and the impact of changes and management measures developed.

INDALO means implementing new monitoring networks to improve existing ones, as well as facilitating the transfer and making available of said information. Consider the following actions:

1. Improvement of sensors and associated infrastructures, expansion of existing infrastructures and creation of new ones, establishment of new sensors, in order to provide greater operability and density to the observation networks.

Network of urban weather stations

implementation of a low frequency network. Stations with basic sensors of temperature and relative humidity, wind, precipitation and soil moisture.

Meteorological Station Network Pinsapo

Mobile data network and stations with temperature and relative humidity sensors, precipitation, wind, soil moisture and mists.

First level Red PINSAPO

Sensors located at some points of the PINSAPO NETWORK to collect direct information about the impact on the tree of environmental variations. Sensors with TDR, dendrometers, sap flows, PRI, infrared and humidity / temperature.

Land-birds Monitoring network

30 GPS-GMS transmitters for tracking individuals of different species, from passiforms to large raptors, to know the patterns and changes of distribution due to Global Change in both breeding and wintering areas.
The issuers and their placement systems will be adapted to the species.

Imperial Eagle tracking network

60 GPS-GSM transmitters for young and adult individuals tracking (wild and reintroduced). To know patterns and changes of distribution due to Global Change in areas of wintering, especially the colonization of new areas due to changes in the distribution of prey.

Network for monitoring Andalusia critical wetlands

15 autonomous low-maintenance multi-parametric buoys.

Network for coastal waters microalgae monitoring

2 multi-parametric probes (temperature, conductivity, pH, depth, oxygen) for depth measurement (up to 50 m) for Mediterranean Sea tropicalization processes monitoring.

Follow-up network of causes of death in cetaceans and sea turtles in the Andalusian coasts

10 Satellite emitters for the monitoring of nesting females and offspring born in nests in the Andalusian coasts.

2. Provision and improvement of the necessary instruments to capture, conserve and analyze data by the Observation Networks.

SEDA First level network

Mobile devices to store the needed information for network points access.

Land-birds Monitoring network

60 Recoti-type automatic recorders that remotely capture edges in large geographical areas

Migratory monitoring of hunting interest

Monitoring with Real Time Locating System methodology

Tracking of predators and small carnivores

120 trap cameras with accessories and consumables. Mobile technology.
Implementation of new density estimation methodologies by photo-trapping.

Monitoring of hunting fauna

100 GPS / GSM collars with data tracking system for space-time monitoring of individuals of certain hunting species (ibex, roe deer ...),

Monitoring network of threatened marine invertebrates and phanerogams

2 Submarine drones to improve data collection and performance of jobs under the sea

3. Acquisition and establishment of storage and communication systems

Indispensable to collect all the information coming from the sensors, sampling points and data collection stations of the Observation Networks (centralized Servers, Data transmission services and Automatic integration systems of the acquired measurements).
The networks that require these improvements are:

- Monitoring of migrants of hunting interest; Monitoring of predators and small carnivores; Hunting wildlife monitoring; Network for ornitolimnological status monitoring of Andalusia critical wetlands

For the execution of this task the following actions will be necessary:

- Analysis and technical studies related to the improvement of observation networks.
- Design and planning of infrastructures linked to the improvement or installation of new sensors.

- Acquisition and supply of sensors & materials; Execution of infrastructures; Installation, calibration and start-up of sensors

4. Establishment of communication systems

Critical to collect key information from Regional Networks through the connection via data transmission services, transformation and systems of automatic data integration.

WP3: TCEs linked to ecosystems and Local Networks of Observation of Global Change

The objective of this WP is the improvement and adaptation of the scientific-technological infrastructure of the TCEs in their performance as Global Change Monitoring Observatories, as well as the Local Networks of Observation of Global Change for monitoring and monitoring of biodiversity and the natural environment in each of the ecosystems under study.

Mediterranean Forest & Mid Mountain TCE

Its objective will be the influence of Global Change on the Biodiversity of these ecosystems and the development of sustainable management tools that guarantee their environmental viability. Generate information that allows modeling the functioning of ecosystems at different spatial and temporal scales. In the case of Mountain Measurement Ecosystems, a network of high density of species, their habitats, their functions and ecosystem services and the environmental factors that affect them.

The University of Córdoba propose equipment and data infrastructure at 4 territorial scale:

1. Macrosystem (Sierra Morena area, >400,000 Has). **Goal**: generate data that simulate the operation of SM, as well as the enrichment of the information generated by other regional networks (SEDA Network) and national (IFN, AEMET).
2. Intensive Monitoring Stations, defined by ecologically delimited zones that contain various types of (socio) ecosystems and assimilated to the concept of (micro) watershed (>1000 Has). **Goal**: to understand the eco-hydrological processes at this scale and to address specific environmental problems through seasonal spectral characterization of ecosystems (UAVs), characterization of pollen and airborne spore production, air and water quality, phenology, humidity of soil, flow and monitoring of meteorological parameters.
3. Ecosystem model (singular), defined by specific forest fragments (1Ha) characteristic of Sierra Morena: pasture, oak, cork oak, mixed forest, pine forests (P. pinea, P. halepensis, P. pinaster), riverbank forests. **Goal**: to characterize, at a detailed scale, the operation of specific forest types through H-T soil/air sensor network, soil and air-soil carbon fluxes and the impact and dynamics of fire.
4. Intensive sensorisation plots established within each "ecosystem model" (500 m2) with high degree of sensorization for the subsystems flora, fauna, soil, climate. Goal: detailed characterization of the functioning of specific individuals and subsystems.

From the University of Jaén a network of intensive monitoring stations distributed throughout the Sub-Béticas Mountains, equipped with automatic meteorological stations to monitor environmental factors of direct incidence on biodiversity, its ecological functions and its ecosystem services, such as carbon fluxes, evapotranspiration, soil temperature and humidity, vegetation phenology.
This would be supplemented with a 2nd network of periodic monitoring points distributed throughout the territory, monitored by portable micrometeorological equipment and drones.

Arid and Semi-Arid Ecosystems TCE

Led by the University of Almería, it will generate and provide continuous data on the impact of climate change and changes in land use and on the functioning of arid ecosystems, with emphasis on the role of biodiversity in carbon and water cycles.
An equipment and data infrastructure organized in 2 levels of spatial scale is proposed:

1. Macrosystem & Mesosystem: units that integrate the arid landscapes of Andalusia, with the aim of generating data to resolve scientific issues and provide useful information for decision-making and regional, national and international observatories
2. Ecosystem Model" (singular), defined by fragments of (socio) ecosystems (bushes, shrubs dependent on groundwater). Its operation and response to Global Change will be studied through carbon and water balances monitoring along the eco-hydrological processes that occur in the critical zone of ecosystems dependent on groundwater. Also the impact of land use changes on the dynamics of aquifers and associated ecosystems. Will establish monitoring stations for the provision of continuous data, and field samplings of essential biodiversity variables with unique equipment.

This TCE could become a node of European scope, taking advantage of the fact that the Arid and Semi-Arid Ecosystems occupy large areas of Spain, Italy, Croatia, Greece and also throughout the Mediterranean Basin (States interested in joining LifeWatch like Israel).

Rivers, Banks and Estuaries Ecosystems TCE

The University of Huelva and INTA with the development of renewable energy systems for feeding sensors and buoys, and IFAPA with actions in the Guadalquivir estuary will participate in its constitution. It will address different issues:
The objective of the action developed by the University of Huelva is to study the impact of climate change on the availability of water resources in the Tinto River basin.
For this, combined sensors of electrical conductivity (CE) and temperature will be used. These devices perform high resolution measurements of CE and temperature, allowing instantaneous transmission of measurements from the sampling point to the laboratory. The waters of the Tinto River are characterized by being very oxidizing and corrosive due to their high acidity and iron content, giving rise to deficient functioning of this type of sensors, limiting their useful life.
Specially designed sensors will be used to perform measurements in more aggressive conditions such as industrial effluents. The use of this equipment would guarantee the on-site measurement of physical-chemical parameters in very corrosive waters and their immediate delivery to technical personnel.

Thematic Center of Excellence on Lakes and Wetlands Ecosystems

Led by the University of Malaga, this TCE will play a leading role in the transfer of data with European repositories such as the European Environment Agency (taking advantage of the fact that the UMA is part of the decentralized structure of the EEA for its participation in the European Topic Center on Urban Land and Soil Systems)
From the University of Malaga, the hydrological and hydrogeological monitoring of wetlands in Andalusia will be carried out by expanding the hydrological and hydrogeological control network of wetlands in areas of regional interest and by using tele-detection techniques.

This TCE could become a node of European scope, taking advantage of the fact that the Wetlands are reservoirs of Biodiversity in Member States such as France, Italy, Greece, Romania, Poland, Finland, Sweden, Germany and the Netherlands.

Water Dammed Bodies Ecosystems TCE

On the part of the University of Seville, the development of a network of observatories of Embalmed Water Quality (ROCAE) will be carried out, which will show physical-chemical and biological information in real time and in continuity. The infrastructure is composed of:

The University of Seville, with the Energy Systems Laboratory (LSE-El Arenosillo) of INTA and collaboration of the Prince Albert I Aquatic Station of Monaco, will develop a network of Water Dammed Bodies Quality Observatories (ROCAE) which will show physic-chemical and biological information in real time and in continuity. The infrastructure is composed of:

- 6 floating buoys and probes anchored above the maximum bathymetric level for the establishment of a monitoring multi-parameter network (University of Seville).
    - Environmental meteorological monitoring system able to vertically move a multi-probe group along the anchor cable to make continuous vertical profiles.
    - Communications node that sends continuous meteorological and water column information to a Hub Node.
- INTA: Energy Generation, Storage & Management system based on renewable energies, for floating monitoring modules.
- Hub Node for storage and normalization processing of information to be sent to the INDALO node.

Thematic Center of Excellence on Coastal Ecosystems

Led by the Universities of Seville and Cádiz, it will develop lines of research on the impact of Global Change in the Coast Zones, from different approaches:
From the University of Seville the following studies will be addressed:
Territorial analysis of indirect drivers of change with greater impact on coastal ecosystems (population, housing land use, infrastructure ...), very vulnerable to the possible effects of climate change (natural risks, health effects, etc.) and with critical impacts on the biodiversity of the coastal system and its provision of ecosystem services to citizens.

The University of Cádiz will study biodiversity associated with migratory phenomena between Europe and Africa. It is proposed to create the Observatory of Biodiversity of the Strait of Gibraltar, an infrastructure for the registration and transfer of data on biodiversity in such a unique area.

This TCE could become a node of European scope, taking advantage of the fact that the Marine Ecosystem has a great importance in the Biodiversity of EU Member States such as Portugal, France, Italy, Croatia, Greece, Bulgaria, Romania, Poland, Latvia, Lithuania, Estonia Germany, the Netherlands, Denmark, Sweden and Finland.

Thematic Center of Excellence on Agro-Ecosystems

Led by IFAPA, it aims to develop an infrastructure that will aim to characterize and monitor the natural and cultivated biodiversity of Andalusian agro-ecosystems, assessing its behavior against the change in three different territorial scales (plot, agricultural exploitation and district). Global, and specifically against the expected changes in the climate (droughts, increase in temperatures, etc).

Several lines of research will be developed:
Establishment of the Cultivated Biodiversity Observatories Network (CBO) consisting of experimental plots, located on IFAPA farms representative of different Andalusian agro-ecosystems, equipped with automatic and semiautomatic sensor networks that will collect significant parameters from agro-ecosystems and transmit it to a Hub Node. Data from IFAPA, which in turn will connect with the INDALO infrastructure.

For the variety of Cultivated Ecosystems studied by IFAPA (cereal, fodder and oilseed fields, olive and fruit tree crops, vineyards, intensive and super-intensive horticultural crops, extensive and intensive pasture and livestock), this center will be created with the aspiration to serve as a convergence node for all European and third-country researchers on Cultivated Ecosystems, which account for 44% of the EU surface (EuroStat), are present in all EU Member States, and are determinant for environmental, food, demographic and public health issues.

Thematic Center of Excellence on Atmospheric Ecosystems

Led by INTA and the University of Huelva, it will address several problems:
INTA will study the potential effect of climate change and the worsening of air quality on the atmospheric environment will be evaluated, for which purpose parameters related to the atmospheric composition (particles and trace gases), meteorology and solar radiation will be monitored; through systematic observations of high quality, with unconventional measurement techniques, on the Atlantic coast of Andalusia.

From the University of Huelva, the effects of Global Change on public health (allergies, with increasing social and economic effects) and on vegetation dynamics will be studied through monitoring the production of pollen and airborne spores in the Atlantic coastal ecosystems.
An excellent database for studies of vegetation dynamics, because climate change affects the time of flowering of plants, and therefore is altering the life cycles of living beings and can be one of the greatest threats to biodiversity .

Thematic Center of Excellence in Ecosystem Genomics

Led by the UPO, it will allow configuring a technological service for Lifewatch and the rest of the scientific community, by means of the construction and equipment of a service of obtaining and analysis of genomic data from DNA samples obtained from the natural environment.
From samples of animal or vegetable origin or from the environment (soil, water or air) the present species can be identified and their relative abundance estimated over space and time, obtaining complete information of their genome and transcriptome allowing their integration with physical data using GPS and temporary labels.
It will be possible to detect the presence and abundance of specific genes in the ecosystem and their gene expression.

Cross-sectioral studies at the regional level

From the University of Malaga, the studies to be carried out will be completed with the construction of a spectral library of soils for the construction of the Spectral Library, by random stratified sampling.
The Center for Landscape and Territory Studies (University of Seville) will carry out studies in the field of environment and territorial sustainability:

- Study of the impact of the demographic, economic, scientific-technical and socio-cultural processes on the Landscape
- Effectiveness of the governance instruments in the monitoring, control and minimization of their negative effects
- Degree of knowledge and awareness of society

WP4: Infrastructure for integrating information. Coordination of data management

In this WP, the work related to information processing and data management will be addressed so that they can be used by the scientific community both at an Andalusian and international level, with special attention to the tasks necessary for integration in LifeWatch ERIC.

At the level of the Hub Node, the information infrastructure will be composed of documentation, cataloging, analysis systems, data transformation, adaptation to standards, database managers and geo-referenced databases.
The infrastructure for the integration of information or data infrastructure gives meaning to the collaboration of the TCEs, and in general to the participation of the Scientific Community, in the LifeWatch ERIC ICT Core e-Infrastructure.
This is because through this infrastructure, all the scientific information is made available to this community in a structured manner so that it is accessible and allows collaborating in research at a European level or improving, through comparative analysis, the research carried out at any point in the EU.

The data infrastructure will include the logical part that will allow the interoperability and harmonization of the data following the existing guidelines or recommendations of LifeWatch ERIC or the sets of good practices and experiences of projects related to LifeWatch and INSPIRE. In this sense, a large part of the work will consist of tasks coordinated by the LifeWatch ERIC to ensure the connection and integration of the data in distributed e-infrastructures and other technological initiatives of a pan-European nature.

This infrastructure will allow to "internationalize" the data by:

1. A system to elaborate and manage the Data Management Plans (DMP) which:
   a) Will meet the FAIR criteria (Findable, Accessible, Interoperable, Reusable)
   b) Will cover the life cycle of the data (Planning, Acquisition, Analysis, Publication, Sanitation, Preservation and Metadata).

   Tools for the automation of the DMP and the scaling of data management will be implemented.
2. Establishment of a system for the generation of broad and standardized metadata: they should be able to be linked automatically with other data sources and be computer-reachable. This metadata, which will follow the recommendations defined by LifeWatch ERIC, will be developed at two levels:
   a) At the data level: in the canonical data model included in the RDO, the necessary attributes will be implemented so that each piece of information has the sufficient descriptive elements so that it can be used by the scientific community
   b) At the dataset level or aggregated data: the data extracted from the RDO for direct exploitation in the management and analysis will be described and included in a Catalog system published in EML format and, for those of a spatial type, in ISO19139 format following the recommendations of the INSPIRE Directive. The datasets will be integrated in the data warehouse (DWHE)
3. Implementation of a system that allows to generate Persistent Unique Identifiers of the digital resources with establishment of the system of safe traces easily managed by computer: versioning of data and metadata that allows to differentiate the data levels (gross, processed, sanitized, ingested and derivatives) .
4. Development of transformation / adaptation tools (ETL): that allow to convert the original data to standardized data in two levels:
   a) Data not aggregated but internationalized for scientific use and its integration in LifeWatch ERIC

b) Development of aggregate data (datasets) optimized for tasks of analysis, research and use in management. In the case that the data sets are of a spatial type, they will be harmonized following the data specifications derived from the INSPIRE Directive.

5. Works for the incorporation into the data infrastructure, specifically in the data warehouse (DWHE), of all the basic information data set currently integrated in REDIAM that is considered of interest to the scientific community
6. Development of tasks for the connection with the GBIF initiative for the integration in the same of those data collected under the INDALO project, specifically those related to lists of species, observations and biological collections and sampling events
7. Connection and transfer of data and developments in the Spanish Inventory of Natural Heritage and Biodiversity (IEPNB)

The data infrastructure will also generate the necessary services to facilitate the use of all the elements integrated in the node by the scientific community as well as the use in virtual laboratories in the international field of LifeWatch ERIC.

In the Hub Node, there will be a platform that provides at least:

- Services and web portals
- Relational database managers
- Managers of georeferenced databases
- Geographic Information analysis Systems (GIS)
- IDE nodes
- Portals to disseminate results beyond the technical and investigative scope
- Information consultation systems (viewers)
- Virtual desktops and virtual laboratories
    - Understanding 'virtual laboratory' an environment that uses ICT to provide its users with different scientific tools for consultation, analysis and data processing, plus a set of data available on which to carry out these activities and solutions for the performance of collaborative work promoting the exchange of methodologies and results between different work groups.

The infrastructure will be designed with the aim of facilitating the management of virtual laboratories when defining and deploying sets of predefined applications and data on which to operate.
It will also provide the information structure converters necessary for the exchange of information with other data banks such as the Spanish Inventory of Natural Heritage and Biodiversity or REDIAM.
The transfer node will have a platform that provides the information structure converters necessary for the exchange of information with the Hub Node (ILWA) and the collection of information from the Global Change Observation Networks of Andalusia. The node will house information on the management scope integrated in REDIAM, and will have IDE services (viewers, cartographic services and metadata) to make this information available to the public and send these data sets to potential users: the administration , for the management of resources; the research groups, for their application in R + D + i and with identical purpose to diverse agents (organizations, companies) and to the citizens like interested part.

In addition, certain partners will also participate in this work package by addressing data infrastructure and data integration in their TCEs.
From the IFAPA, the creation of the Spatial and Alphanumeric Data Infrastructure coming from the different types of sensors of the system will be approached, as well as the digital transformation and integration of data series of pre-existing networks of the field of agricultural

research (IFAPA) and management (CAPDR), related to cultivated biodiversity and drivers of Global Change.

The Development of a web platform for the spatial integration of demographic, urban and infrastructure data will be addressed from the University of Seville following the design principles and deployment best practices established by LifeWatch ERIC ICT Core.
Designed based on a distributed architecture of microservices (open source software), being Docker containerization technology responsible for controlling and creating microservices.
This structure would provide high horizontal scalability and high replicability in other European coastal environments environments compulsory through the LifeWatch ERIC Blockchain Platform (**LifeBlock**). Integrated into the project's server infrastructure (CICA), it would be composed of the following components:

- The central service would be a multidimensional multiscale grating manufacturer (CellGridder): it deals with the work of constructing the multi-scalar grids (definable by the user) from the access to the original data, guaranteeing the spatial integration of the same (population, coastal erosion, flood ..). The original "anthropic" data that would feed this service would require the development of specific APIs or the development of software that guarantees periodic or immediate access to: the baseline information (population, uses, cadastre, ..)
- Spatial Data Infrastructure of demographic, urban variables and infrastructures through the generation of interoperable services OGC (map servers like Geoserver) and a REST API for access to integrated data.

From the University of Huelva will be undertaken the generation of mapping of natural ecosystems of Sierra Morena, from the processing of raw data LiDAR, allows the study of the vertical and horizontal structure of the habitat and thus better understand the distribution and abundance of biodiversity.
Vertical ecosystem structural complexity (average height of vegetation, vegetation volume, micro-topography) is relevant to analyze biodiversity, detect changes in the landscape and model the forest carbon store, and understand the role of forests in mitigating climate change.

Finally, the University of Malaga will address the generation of access services to and from data contained in European repositories through **LifeBlock**.

WP5: Communication, dissemination and connection with other international infrastructures

General Communication Objectives

The general objectives that have been marked are directed not only to the ÍNDALO Consortium, but also to its integration within the framework of LifeWatch are three:

1) Manage and coordinate the flow of information among the participants in the project so that it is effective, and contribute to good communication within the ÍNDALO Consortium.
2) Inform and publicize the project among the interested parties within the ÍNDALO Consortium and the LifeWatch Consortium, as well as national, European and international institutions, related to the scope of the project.
3) Promote accessions to ÍNDALO and LifeWatch through the dissemination of the progress made and the dissemination of results and achievements.

The communication activities of the project will be integrated in the overall communication strategy that LifeWatch ERIC will establish in order to coordinate all projects´ efforts, increase the overall impact and provide homogeneous message of the potential of LifeWatch ERIC,

reinforcing the visibility of the research and innovation potential of the Andalusia Region and deeply reaching all stakeholders.

This task will be performed in tightly collaboration with the Statutory Seat (Common Facility in Spain) Communication Responsible.

Specific Communication Objectives

The specific objectives are specified in a differentiated way for internal communication and external communication.

Objectives established for external communication:

1) Awaken the interest of environmental managers and the research and scientific community for the collaboration and search for synergies aimed at improving the study and management of Biodiversity
2) Promote the connection between the scientific and research community involved in ÍNDALO for the exchange and transfer of knowledge, and between this and the environmental managers
3) Form a community with key stakeholders related to the objectives of this project that guarantees the appropriation of the final results and ensures its capitalization
4) Demonstrate and sensitize the scientific and research communities, environmental managers, SMEs, associations and organizations, and citizens acting in this field, the potential that offers to share knowledge to put them at the service of the protection of the environment and the general interest of the citizenship
5) Coordinate with other stakeholders in the framework of LifeWatch to share all that information of interest (seminars, events, exchange networks, good practices, progress and achievements, etc.), and generate a reciprocal exchange.
6) Generate a documentary and material base as a result of the actions carried out within the framework of this project (with digital resources: videos and images gallery, papers, publications in digital magazines, results reports, etc.)

Specific objectives of internal communication:

1) Develop protocols that systematize the different levels of communication between the people involved in the project, which are a clear guide when communicating any information: communication channels that will be used, frequency and relevance, priority, recipients of each type of communication, etc.
2) Keep informed the different stakeholders in ÍNDALO about those activities and actions to develop, administrative and financial issues, control and follow-up, modifications and evaluation of the project, in short on the implementation of the same.
3) Facilitate the exchange and communication with the LifeWatch Service Center to the TCEs and environmental managers.

Management and Coordination

A Management and Coordination structure will be responsible for the preparation of a Communication Plan, which will include activities for the capitalization of the results of INDALO.

A **Communication Director** will be the last person in charge of the management and coordination of the Communication of the project, and of the planning, writing and implementation of the Communication Plan.
He will be the direct interlocutor with the Project Director of ÍNDALO, and whoever maintains the necessary contact with his counterparts in LifeWatch ERIC, especially with the Statutory Seat (Common Facility in Spain) Communication Responsible, to ensure the necessary coordination of actions and messages.

A **Communication Committee** composed of:

- The Communication Director
- A representative of each University and Research Center of those that are part of the Consortium. This will work as a link between the project and the universities / centers for this matter.
- The Statutory Seat (Common Facility in Spain) Communication Responsible

In turn, participating Universities and research centers must make available to the project a person in charge of the Communication, who will maintain direct contact with the representative of Universities. (in the case that there is only one representative of Universities) The composition, functions and competencies of the Communication Commission and the Communication Director will be included and expanded in the Communication Plan.

Communication plan

The Communication Plan will be prepared by the Communication Commission, under the direction of the Communication Director. It will have the relevant contributions of the ÍNDALO Consortium. We will work mainly in a remote environment (skype, multiparty, mail, etc.) to optimize human and economic resources, and streamline tasks.
The Communication Plan will be the strategic tool that will serve as the basis for the management and coordination of the Communication and Capitalization of the project. In the will contemplate issues such as:

1. Internal and external communication (online, offline and face-to-face strategy).
2. Communication Commission: composition, objectives, coordination, reports
3. Human and material resources
4. Schedule
5. Control and monitoring of communication; Communication Plan updates
6. Evaluations and indicators of the performance and impact of communication
7. Budget

The Communication Plan will have a series of activities designed to capitalize the final results, to guarantee the transfer to other key territories, beyond those directly affected by the project, and to ensure that the results are used in the form of new instruments ; create exchange networks and expand existing ones; prepare new proposals; look for accessions

The Communication strategy will be directed to:

- Prioritize the use of tools that optimize:
  - Maximum audience (ICT, media, events).
  - Temporary and economic sustainability (electronic versions when possible).
  - Participatory and interactive communication (events, social networks).
  - Visual communication (video interviews, promotional material and video gallery).
- Make Communication:
  - Adapted to the public (language, messages, texts, etc.).
  - Accessible for all (tool for people with functional diversity - deaf, blind, mobility problems, ... -
- That relevance be given to and promote the visibility of women, both the participants in the project and outside it:
  - As protagonists in the world of Science, Research and Innovation. The gender dimension in the content of research and innovation can be highlighted
  - As decision makers in ÍNDALO
  - As representatives in environmental institutions and related to the project
- The use of different channels with the aim of reaching the maximum possible public:

- Online Activities (social networks, videos, etc.)
- Offline activities (in different media: press, radio, tv)
- Face-to-face activities (seminars, conferences, meetings)

Activity 1 Web-site	Website based on "responsive design" to be accessible from all types of devices with Internet access. Oriented towards the creation of a community around the project. It will be associated with social networks. A Strategic Web Content Plan (objectives, selection criteria and content management procedures) and Social Networks (those that make sense in this project, such as Twitter or Linkedin) will be developed.
Activity 2 Logo and Corporate Image	The co-design of a corporate image will allow the project to have its own identity, making it recognizable and associating it with the values of the project. It will be integrated with the LifeWatch ERIC logo and image, and therefore must compulsory count on LifeWatch ERIC supervision and approval in order to comply its trademark & branding international regulations. A Logo and Corporate Identity Manual will be created that will establish the rules of use and the different usable formats. This Manual will be the basis for regulating the production of all communication or promotional material within the Consortium.
Activity 3 Public awareness and awareness campaigns	Extension and promotion of Citizen Science
Activity 4 Capitalization of Results	Events of presentation of the project and its results achieved

Internal communication will be supported by all the ICT tools currently available to facilitate cross-border work. As main tools that will be used: email, Skype, Doodle, Google Drive, Dropbox.

At the beginning of the project, the Technical Secretariat will prepare a database with people involved in the project, attributed roles, and contact data. Document templates will also be produced for the uniform collection of information.

WP6: Operational, Administrative and Budgetary Coordination

Given the magnitude and complexity of this project, **Governance and Management bodies** will be created to guarantee the correct execution of it.
AMAYA, as the coordinating partner and principal beneficiary of the project, will be responsible for the administrative, budgetary and operational management of the project.
It will be responsible for the contact and for providing the expected reports to the International LifeWatch ERIC ICT Core, Statutory Seat-FEDERTECH Technical Offices.
INDALO will contribute with the LifeWatch ERIC "FEDERTECH" office on institutional communication and legal-administrative task.
The rest of the project partners will be responsible for providing in the foreseen terms all the necessary information for the correct execution of the obligations of the coordinating partner.
In this sense, the project partners explicitly commit themselves to comply promptly with the indications and requests for information in the form and time period requested by the coordinating partner, as well as to ensure the quality of said information.

To this end, AMAYA will designate a **Project Management Team (PMT)**, composed of a **Project Director** and a **Technical Administrative and Financial Management Team**.
These profiles will be assigned the following functions:

Project Director

Will be the direct interlocutor on behalf of INDALO with LifeWatch International and LifeWatch ERIC. Will ensure the quality actions implementation, the calendar compliance and the coherence of the technical and informative contents of the project:

- Ensuring fluid communication among all project partners, especially at the institutional level.
- Facilitating and anticipating those project needs that depend on any aspect related to the environmental authority (Junta de Andalucía) or any of its bodies
    - Specially those that can contribute to enhance the objectives of the project or the impact of the actions.
- Supervising the progress of the project communicated by the Administrative and Financial Management Technical Team and detect gaps or delays in the fulfillment of the objectives, and adopting the necessary corrections.
- Supervising the drafting and application of a "Risk Management Plan"

Technical Team for Project Administrative and Financial Management

Its function will be to guarantee administrative control, assuming the responsibility of:

- Drafting & Applying a "Quality Plan" which will establish the indicators, objectives and internal procedures.
- Periodically monitor the implementation indicators of the actions,
- Inform during the coordination meetings of the state of Administrative Management.
- Direct contact with partners and project staff on a day-to-day basis,
- Collect and redistribute the information produced by the partners, especially at the level of writing internal, public reports or for LifeWatch International and LifeWatch ERIC.

Regularly inform the Project Director about the collection of all the necessary information for the evaluation of the indicators and results, and on the issuance of reports.

Its function will be to guarantee the financial and accounting control of the project, as well as the supervision and supervision in these aspects of the rest of the partners, all in constant coordination with the Director and the Administrative Team of the Project Management:

- Regularly inform the Project Director about all the details related to the financial execution of the project.
- Prepare monthly reports on economic follow-up and progress of the project, which will be sent to all project partners.
- Attend the meetings of the Technical Follow-up Committee at the request of the Project Director.
    - In these meetings the project management team (mentioned above) will participate. The partners will be informed of the progress of the project and the results of the actions, with special attention to the problems encountered, and to coordination and development of synergies.
- Prepare the reports: Startup, progress reports, intermediate and final reports with payment requests. Also the project audit report.

The Internal Governance Bodies of INDALO will be:

INDALO Board of Directors

It is the definitive decision making body of the Consortium.
It will hold two regular meetings per year, and as many extraordinary meetings as necessary, and they will be compulsorily face-to-face.
It will be composed of 1 representative of each of the following:

- Project Director

- INDALO Partners
- ICT Core Lifewatch ERIC
- Coordinator / Impulse Authority

The execution and adequate application of the decisions of the Board of Directors will correspond to the Executive Board.

INDALO Executive Board

It is the supervisory body for the execution of the Project that will report and report to the Board of Directors.
Prepare monthly Project Monitoring Reports, Meetings, propose decisions and prepare the agenda of the Board of Directors. It meets **monthly** and is composed of:

- Project Director
- Administrative and Budgetary Management Teams
- Representatives of the Partners that are called to each meeting

INDALO Technical Committee for Project's Follow-up

A Technical Committee to Monitor the Project will be set up, which will be an Organ for representation and participation of all the partners of INDALO.
It will meet **quarterly**, not necessarily in person (tele-conferences are allowed).
It will be informed monthly by the Director of the INDALO Project through Follow-up Reports sent by email.
This body will be responsible for approving the "Consortium Plan" and any modifications to it that are made during the execution of INDALO (changes in the Payment Schedule, in the Execution Schedule, in the Deliverables, Indicators or Expected Results).

Coordinator / Impulsive Authority of the INDALO Project

The Coordinator, role assumed by the Ministry of Agriculture, Livestock, Fisheries and Sustainable Development, is the legal entity that acts as an intermediary between the INDALO Project and the Institutions that compose it and the International LifeWatch Technical Office.
It constitutes the maximum institutional authority of the INDALO Proposal, and will not assume day-to-day management but executive functions:

- It is the figure that the Authority has in the project and that delegates its execution to the Project Director
- Can act as an intermediary between the parties and the Ministry
- Provides the necessary resources (economic, human, etc.) and supports the project
- Involved in the resolution of incidents and deviations that affect the project
- It is the spokesman in front of the different Councils of the Junta de Andalucía, Ministries, Organizations responsible for this project in the EU to get support for INDALO in any event or in a strategic way.
- Mark the guidelines and guide important decision making:
    - Management of Project Funds and possible injection of additional funds
    - Formalize the project closure

Responsibilities:

- Maintain the list of addresses of members and other contact persons updated and available
- The transmission of documents and information related to the Project of any other interested Parties

Schedule


YEAR 1
YEAR 2
YEAR 3
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12
WP1 - VRE INDALO: HW and SW Architecture
Tenders
HW Installation and Set-up
Requirements & Functional Analysis
SW development
Tests
Maintenance and Update tasks
WP2 - Adequacy of Regional Networks
Tenders
HW Installation and Set-up
Requirements & Functional Analysis
SW development
Tests
Maintenance and Update tasks
WP3 – Implement TCEs
Tenders
HW Installation and Set-up
Requirements & Functional Analysis
SW development
Tests
Maintenance and Update tasks
WP4 – Data Infrastructure, Coord. & Management
Approval of methodologies and standards
Appointment responsible in each partner
Standardization tests.
Establishment and maintenance of information flows
WP5 – Communication & dissemination
Web content generation (multimedia)
Multimedia contents editing
National events of diffusion / capitalization
International events of diffusion / capitalization
WP6 - Governance
Governing Bodies Consitution
Board of Directors Meetings
Executive Board Meetings
Monitoring report
Technical Monitoring Committee Meetings
Knowledge Transfer Committee Meetings
Administrative management (& partners' support)
Financial management
Progress Reports

Knowledge Transfer Committee

The Knowledge Transfer Committee will be the body in charge of promoting the application of research in the development of public policies and the encouragement of R&D&I by the private sector, with special emphasis on encouraging the collaboration of partners in iNDALO with the Andalusian productive fabric, especially with local SMEs.
In this Committee AMAYA and the AAC will participate, with a double objective:

- Ensure the effective transfer of knowledge to the field of management and administration (AMAYA)
- Promote the knowledge and researching results transfer, the R&D&I among companies and public agents of the Andalusian System of Knowledge, and their joint participation in international projects. (AAC)

B2.2. E-Services and Virtual Research Environments (VREs)

VRE

INDALO will constitute a VRE common to all the partners that make up the project, and open to the incorporation of new institutions that develop Science and Innovation in the field of biodiversity observation.
The INDALO partners will disseminate this VRE among the Research Groups not yet involved, so that they can be incorporated in the shortest timeframe. In this regard, it is worth mentioning that research grants from the Ministries of Science and Innovation and of Environment and Territorial Planning will take precedence over those projects that are incorporated into the philosophy and the LW e-infrastructure.

To achieve a common VRE, INDALO has designed an HW architecture that reflects the idea of LW based on the experience of REDIAM. This architecture, which is explained below, will allow an adequate flow of scientific information as well as the collection of information on Biodiversity and its normalization to serve in the identification of the indicators of the Global Change process.

e-Services

Within the framework of VRE INDALO, a series of services will be created that will provide tools and access to data and research projects to facilitate collaborative R&D&i.
These services will have different levels of access to be able to focus on the following innovation agents: Research Centers, Innovative companies (or susceptible to developing R&D&i), Administration (to apply scientific advances in environmental management), Third Sector (NGOs and Foundations susceptible to collaborate in science and R&D&i) and Citizenship (to stimulate citizen science).

The data infrastructure will generate the necessary services to facilitate the use of all the elements integrated in the node by the scientific community as well as the use in virtual laboratories in the international field of LifeWatch ERIC. The following e-services will be developed:

General Data Access Services: Allows you to download a table with a historical series of data in a given scope (The service performs operations to extract, organize and display the requested data, it is not the simple download of a closed table, but rather generates a table that responds to the request of the user)

Services for the massive transformation of data from official statistical sources into scientific data The transformation of statistical or cadastral data can be transformed into an LW service; the user accesses a web form in which he indicates what data he needs and the type of transformation, and then the Service resolves both the request of the raw data, the download of these and the transformation in an automated way

Geospatial Services: They allow converting alphanumeric data in graphics (maps), that can be visualized in different viewers.

Other services such as Species Identification Services.

Data access services

They will perform operations to extract, organize and display the requested data, not only the download of a closed table but the generation of a table that responds to the specific demand (query) of the user.

The VRE INDALO includes in its Hub Node a repository of data (and documents, see following e-Service) that allows to host in a centralized way in a cloud of servers both the raw data generated by the research and the processed information, research articles, dissemination documents, materials for teaching, etc ...The services that will be developed are:

- Service for access to the European data repository of the EEA
- Repository of geological and Soils data
- OGC interoperable services of both original data and transformed into multi-scalar / multidimensional grids (WFS, WCS, WMS, WMTS, etc ...)
- Access service (repository upload and download) to data by geospatial criteria:
- Multimedia data (photos and videos)
- Statistical data (counts ...)
- Web client for access to atmospheric data according to geo-spatial criteria
- Solar radiation, total ozone, meteorology (temperature, wind speed and direction, humidity and pressure), air quality parameters (PM10, PM2.5, O3, NO2, CO and SO2), optical thickness of aerosols (AOD) and satellite data.
- Access service to geospatial data of the Arid Zone Ecosystem
- Critical areas
- Monitoring of water cycles, carbon, energy
- Wetlands Monitoring Service based on Big Data analysis
- Geo-viewer for accessing data from the Biological Balance Tracking Network
- Geo-viewer for access to data on Ecosystems under study charged by the TCEs (both raw and standardized data)
- Early warning service for climate risks in different Ecosystems
- System for monitoring the effects of high and low intensity forest fires
- Service of access to data from Monitoring Networks:
- Satellite biodiversity and geo-location monitoring network (GIBSAT).
- Distribution of populations and phenology of wildlife in the Mediterranean Forest Ecosystem

Services for the massive transformation of open data into scientific data

The transformation of statistical or cadastral data can be transformed into an LW Service; the user accesses a web form in which he indicates what data he needs and the type of transformation, and then the Service resolves both the request of the raw data, the download of these and the transformation in an automated way

- Generalist services for access and transformation of cartographic data from official sources (Cadastre, SIGPAC)

- General services for accessing and transforming satellite data from official sources (COPERNICUS, ESA, EEA) through specific APIs
- Generalist services of access and transformation of statistical data and time series of Population (INE, IECA, Municipal Register of Inhabitants)
- Generalist services for access and transformation of statistical data and time series of Biodiversity (National Forestry Inventory)
- General services for access and transformation of geo-positioning data (mobile telephony) and social networks (Twitter, Facebook, Instagram).
- Data management and transformation platform (normalization, standardization)

Geo-Spatial Services

Web clients that allow converting alphanumeric data into maps, which can be viewed in different viewers, and perform geographical analysis on them.

- Geo-viewers for the processing and visualization of spatial information on Biodiversity in different Ecosystems (generation of vectorial / raster maps)
- Geo-viewers and dashboard that will allow visualization, management of semiology, exploration through interactive graphics and analysis (Machine Learning) in client on the visualized data
- Geo-viewers to track behaviors through time and space of different variables
    - Physical-chemical
    - Moisture floors
    - Distribution of fauna and flora
    - Anthropic impacts on ecosystems or landscape
    - Forest and agrarian inventories, property regime
- Geo-viewer of prediction, mitigation and analysis of risks caused by agro-meteorological droughts (tabular format and spatial viewer)

Species identification services

They will allow the user to upload a photo of a species (photo-trapping) and have the service identify it accurately.

- Identification services for flora and fauna species (especially invertebrates) on land. Focused on Research Groups and Citizenship (to stimulate Awareness and Citizen Science)

B2.3. Socio-economic effects of the project: Knowledge transfer

Employment and economic activity

In terms of employment and economic activity, a positive effect is expected in the region by encouraging the participation of the business sector in advanced scientific and technical infrastructures as users and as suppliers of technology.
It is also expected to favor the development of human capital in the field of research, in terms of the technical and research staff that participates in the project, with the consequent impact on the human resources dedicated to INDALO and with the creation and development of new skills and competencies

Cooperation between organizations will be encouraged along the value chain. INDALO will increase communication between research and management institutions, which will advance the experience of collaboration between knowledge generating entities (scientific teams) and policy and territorial managers (administrations).

Private sector collaboration: foster SMEs R&D&i

INDALO will seek to increase the business financing of R&D&i by stimulating the use of technological infrastructures and LifeWatch information by companies to generate economic activity in the following areas of the private sector:

1. Technological companies
2. Agro-forestry companies (better planned agro-forestry exploitation, monitoring of crops, development of inputs, development of phytosanitary products)
3. Tourism companies (active tourism that takes advantage of Open Data to create new products and better exploit the potentials of niches such as bird-watching)

In this sense, it is expected that the project contributes to the technological and strategic development of Andalusia and supposes a lever to stimulate the investment of SMEs in R&D&i.

Exploitation of infrastructure by other R&D&i stakeholders

As discussed in the previous section, the use of technological infrastructures by companies in specific sectors will be encouraged, which will encourage the alternative or additional use of the network to other areas in which the project's products and / or the Knowledge generated by INDALO can be applied

Knowledge transfer

The transfer of knowledge will have two vectors with INDALO:

- The stimulation of business R&D&i, through mechanisms that facilitate the connection between the institutions participating in INDALO with private sector companies able to take advantage of the results of LW
- Institutional cooperation for the development of more effective and efficient public policies, a pillar of the welfare state that is particularly in need of this transfer in a context of accelerated technological and social changes and shrinking public budgets.

The instruments to develop both lines will be:

1. Specific funding commitments of scientific research that will prioritize the development of collaborative science through participation in LW, by the Knowledge, Research and University Departments, and CAGPDS
2. Governance focused on the Transfer of Knowledge. As developed in the governance chapter, the Knowledge Transfer Committee will have as its specific mission the promotion of this issue. To do this, it will develop the following functions:
    a) Presentation of semiannual reports with contributions from INDALO for Public Policies and improvements in the areas of the Administrative Management. These reports will gather the advances in the research generated by partners of the INDALO Consortium that are susceptible of immediate application in the public sector.
    b) Annual reports with the identification of applications in economic sectors of science developed within the framework of LW
    c) Continuous liaison with the company to promote basic science applications in private R&D&i through the development of joint projects or other collaboration formulas.
3. Development of an annual Forum with the OTRIs (Offices for the Transfer of Research Results, the bodies of the Universities specifically responsible for fostering the research-business link), for the exchange of methodologies and information, and for the planning of specific actions.

The role that the Andalusian Knowledge Agency can play in transference and dissemination of results will be key, being the nexus for the private sector to take advantage of the LifeWatch e-Infrastructure and the data infrastructures generated by public research institutions.

Its nature as Hub of the Andalusian Knowledge Agents and its membership in the Enterprise Europe Network (EEN) will facilitate a greater impact in the dissemination of results and the promotion of knowledge transfer processes with other stakeholders (regional, national and international).

Citizen Science

INDALO will stimulate the participation in science both of the citizenship and of the Third Sector (it is special the associations and NGOs of defense of the nature more linked to the Defense of Ecosystems and Biodiversity: IUCN, WWF, SEO, ...).
The INDALO Consortium has identified the following areas in which Citizen Science will be incorporated into the research carried out by the TCEs:

Fauna censuses

Mainly in the Ecosystems of Lakes and Wetlands, Rivers and Banks, Coastal, Marine and Urban
Participation in counting and banding campaigns for protected avifauna species (Example: populations of pink flamingos in Laguna de Fuente de Piedra), and census of mammals, fish and birds, both permanent and migratory

Scientific tests

Mainly in Agro-ecosystems, in which the participation of companies and citizens (in their capacity as owners of certain plots or farmers linked to certain uses and crops) can be decisive to analyze impacts on the Biodiversity of agricultural practices, phytosanitary products, etc…

B2.4. Target audience and Stakeholders involved in the project

Target Audience

Scientific community:

Teachers, Students, Researchers

Private company (especially SMEs)

Technological companies as Service providers; **Agro-forestry** companies (better planned agro-forestry exploitation, monitoring of crops, development of inputs, as well as phytosanitary products) & **Tourism** companies (that take advantage of Open Data to create new products and better exploit the potentials of niches like bird-watching, trekking, etc.)

Citizenship

For a question of transparency and accountability, and to explore all the possibilities offered by Citizen Science (see B2.3)

Administrations

With the aim of transferring to Management the latest advances and approaches offered by basic or applied science.

Stakeholders involved in INDALO

1) Environment and Water Agency of Andalusia (AMAYA)

The Agency for the Environment and Water of Andalusia will act as the responsible partner and main beneficiary of the INDALO project, ensuring connections between the INDALO Hub Node, the TCEs and the regional and local observation networks. It will also ensure the flow

of data and exchange of information between the participating institutions and the normalization and adaptation of the same to the LIFEWATCH standards. It will provide virtual work environments for technicians and researchers, and the dissemination and exploitation of data through the development of e-services.

2) Andalusian Agency of Knowledge (AAC)

The AAC, instrumental entity attached to the Regional Ministry of Economy, Knowledge, Business and University has defined competencies in matters of promotion and management of R&D&I and knowledge transfer, in evaluation and accreditation of Andalusian University System and, in general, of the R&D&I activities of Andalusian System of Knowledge agents.
Through the Scientific Information Center of Andalusia (CICA), it will be responsible for the deployment and installation of the infrastructure of the INDALO project, and will serve as a support platform for:

- Scientific work on the interrelationships between the Global Change process and biodiversity and the functioning of ecosystems
- The subsequent R&D&I
- The transfer of science and innovation to sectoral and territorial management

3) IFAPA

IFAPA is the only Public Organism of Investigation OPI of the agrarian field of Andalusia, assigned to the Ministry of Agriculture, Fishing and Rural Development CAPDR.
IFAPA has 18 research and transfer centers distributed throughout Andalusia, and more than 1300 ha of experimental farms.
Among its workforce of 800 employees, IFAPA has 244 highly qualified researchers and technicians in agricultural experimentation techniques, remote sensing and the use of sensors resulting from work carried out in research and transfer projects in the last 30 years.

4) INTA National Institute of Aerospace Technology

INTA is the Public Research Organization attached to the Ministry of Defense. Its activities will be driven through the Atmospheric Sounding Station (ESAt-El Arenosillo), dependent on the Atmospheric Research and Instrumentation Department of INTA (AIIA)
With a strong commitment in the maintenance of high quality and long-period atmospheric observations, it participates in observation networks such as AERONET / NASA, FAN / NOAA, MPLnet / NASA and EUBREWNET. It is also part of the European ACTRIS consortium, an initiative included in the ESFRI roadmap.

5) UAL

The University of Almeria has extensive experience in coordination and management of national and international R&D&I projects. Its lines are ecosystem monitoring and adaptation to global change, the science-management interface for the improvement of decision making and the citizenship involvement in processes of adaptation to Global Change.
In 2014 it was constituted in "The Arid Iberian South East LTER Platform" (LTER_EU_EN_027).

6) UCO

The University of Córdoba has extensive experience in the management and execution of national and international research, innovation and technology transfer projects (FEDER, CDTI, H2020, FPn and others), with 52 H2020 / FP7 projects and 37 projects financed by other programs Europeans in the period 2007-2018.
Many of their research groups are references in the field of monitoring, mitigation and adaptation to climate change in their different specific disciplines.

7) UJA

The University of Jaén has 7 research groups on biodiversity, encompassing more than 40 researchers in the field. There are also 5 other research groups in lines related to telematics, atmospheric modeling, geographic information systems and photogrammetric systems.
The university has Centers for Advanced Studies in Earth Sciences (CEACT), in Energy and Environment (CEAEMA) and in Information and Communication Technologies (CEATIC), and also participates in the Interuniversity Institute for Earth System Research in Andalusia (IISTA).

8) UCA

The University of Cádiz has 19 research groups in the field of Natural Resources and the Environment, covering lines related to Aquatic Ecosystems, Coastal Wetlands, Oceanography, Marine Biology and Geology and Coastal and Marine Geophysics.

9) USE

The University of Seville has a long experience in projects that emphasize the use of technologies such as GIS, Remote Sensing, machine learning, web mapping or citizen science in the analysis of coastal risks and vulnerability both at the national level (National projects), Europe (PEGASO: People for Ecosystem Based Governance in Assessing Sustainable Development of Ocean and Coast -FP7-ENV-2009-244170- or SPICOSA - Science and Policy Integration for Coastal System Assessment -FP6-SUSTDEV-2005-36992-) and development of infrastructures for international networks (Interreg, ICAN-International Coastal Atlas Network-).

10) UHU

The University of Huelva, through the Andalusian Network of Aerobiology (RAA) with 11 Monitoring Units throughout its territory, plays a fundamental role in the field of the analysis of the concentration of pollen and spores in the atmosphere, which has been an excellent database for studies of vegetation dynamics and public health (allergies).
Also noteworthy are the studies related to the impact of global change on the quality of water bodies, especially in areas of mining activity, relevant in the province of Huelva.

11) UPO

Pablo de Olavide University leads the Campus of Excellence CEI Cambio, dedicated to the investigation of Biodiversity and Global Change.
It was the first university to be certified according to the ISO / IEC 20000-1: 2005 standard, quality standard in IT service management, and guarantee in technological project management.

12) UMA

The University of Málaga plays a key role in INDALO for its contribution and scientific career, as well as being part of the decentralized structure of the European Environment Agency (EEA) through its participation in the European Topic Center on Urban Land and Soil Systems.
Therefore, it will play a key role in the internationalization of INDALO.

Horizontal Principles applied to the composition and operation of INDALO

Sustainable development

For the horizontal principle of Sustainable Development, INDALO has taken into account intervention criteria focused on the protection and care of the environment.

Regarding the planned infrastructures, none of them lye within the spaces affected by the Environmental Impact Assessment Directive and the Habitats Directive.

In WP5 & WP6 activities the aim will be the lowest possible cost and minimum consumption of resources, taking advantage of technologies to avoid the use of paper and to gain the maximum impact and diffusion. Re recyclable and less polluting materials will be a priority.

Equality of opportunity and non-discrimination

ÍNDALO, in accordance with LW Statutes and the Horizontal Principles of P.O.P.E. 14-20 will promote equal opportunities and non-discrimination, favor multicultural and multidisciplinary environments, promote excellence through diversity, as well as the incorporation and integration of researchers and doctors with disabilities in activities and governance bodies.

It will enable researchers and people with functional diversity (with sensory or mobility difficulties) access to INDALO by providing digital accessibility and assistive technologies for communication accessible to all, with dissemination tools and adapted content, accessibility in the spaces intended to networking, meetings, etc., and a focus on the design of proposals with inclusive measures that respect the needs of these people.
The advice, support and collaboration of associations or entities such as Reiddis (Spanish Network of Researchers and Doctors with Disabilities), CENTAC (National Center for Accessibility Technologies), ILUNION, or entities of the Third Sector will be sought.

Equality between men and women

INDALO opens a window of opportunity to reinforce the role of women in the scientific and research field, and ensure equal treatment and opportunities between men and women, avoid the loss and flight of female talent and boost quality and excellence in science.
To this end, a series of measures will be developed at different levels:

- Governing bodies: balanced participation of women and men in both the decision-making and project management processes
- Research teams: supporting the incorporation of women in research projects in all its phases (design, execution, monitoring and control, evaluation, management, etc.)
- R & D & I criteria and mechanisms for the integration of the gender dimension will be established, given the importance of the gender perspective.
- Evaluation of women's participation: promoting data disaggregated by gender.
- Project Communication & dissemination: greater visibility to women's contributions. Women’s presence will be encouraged, and awareness tasks will be carried out on the importance of the gender dimension in the scientific and research field.

In the preparation and design of this proposal, the participation of women has been parity

The collaboration of the Women and Science Unit of the Ministry of Economy and Competitiveness, Women's Institute, Gender Equality Units of the Universities will be sought, and family conciliation will be favored in the execution of the proposed actions. Links will be established with GENDERWATCH with the view to develop specific gender and biodiversity strategic alliances

Participation of JRU LW.ES and LW ERIC members

INDALO will encourage the participation of JRU LW members as international experts assigned to the actions promoted by its partners, and will devote special attention to the promotion and participation in international projects in collaboration with the ERIC LW team.

B2.5. Internationalization of the proposal

For INDALO it will be a priority to stimulate the link between science and innovation developed in Andalusia with its EU counterparts.

Through INDALO, a large volume of organized and systematized information will be offered to the scientific community of the EU, which will undoubtedly represent an incentive for the incorporation of international research centers into the LIFEWATCH infrastructure.
The information that will be accessible has two great values:

- Correspond to the observation of representative ecosystems of European Biodiversity
- It will give access to the historical data of the last 30 years, and to real-time data captured by REDIAM (one of the most complete networks with the longest trajectory in observing the EU's environment) and by other partners of the Consortium as IFAPA.

The partners of INDALO guarantee a high degree of internationalization of the e-Services and Data Infrastructures that they will make available to scientific organizations in Europe and other Regions of the world, given the existing links with the following institutions:

Connection with Universities and International Technology Centers

International universities and research centers connected with INDALO partners in current research projects on Biodiversity and/or Global Change are:
VU- Amsterdam, Wageningen, Twente (**Netherlands**); Universitá degli Studi Cagliari, Sassari, Firenze, Bari (**Italy**); Institute of Agrosystems and Bioclimatology Brno (**Czeck Republic**); Lubljana Univ. (**Slovenia**); Antwerp (**Belgium**); Leibniz Un Hannover, Bonn, Göttingen, Potsdam Institute for Climate Impact Research, Leibniz-Centre for Agricultural Landscape Research & 16. Leibniz Centre for Tropical Marine Research Bremen, Berlin (**Germany**); University of Veterinary Medicine Vienna, Natural History Museum Vienna (**Austria**); Lyon1, Grenoble 1, Lorraine Nancy, Joseph Fourier, Grenoble & INRA Avignon (**France**); Aveiro, Algarve (**Portugal**); Stockholm Resilience Centre & Lund University (**Sweden**); Copenhagen Univ (**Denmark**); Finnish Environment Institute (SYKE) Helsinki, Natural Resources Institute (LUKE) (**Finland**); Open University (**Cyprus**); University College of London in Ulster, Birmingham Univ., Exeter Univ, Rothamsed Research Harpenden (**United Kingdom**), Swiss Federal Institute of Aquatic Science and Technology, Dubendorf; Swiss Federal Institute of Technology (ETH), Zürich; Genetic Diversity Centre; Swiss Ornithological Institute, Sempach (**Switzerland**); NTNU (**Norway**); University of Buffalo, Oregon State Univ., University of Arizona, University of Virginia (**USA**); Univ. Buenos Aires, Univ. Nacional de San Luis (**Argentina**); Univ. Abdelmalek Essaâdi, Univ. Mohamed I Oujda (**Morocco**); Institute of Socioecology (**Israel**).

International Networks

ICAN (International Coastal Atlas), RIDOT (Ibero-American Network of Territorial Observation), CLACSO Latin American Council of Social Sciences, UNISCAPE European Network of Universities, LTER Long-Term Ecosystem Research in Europe Network, ISMC-International soil moisture Consortium, Sustainability of permanent Grasslands CONSORTIUM, Joint Research Center EC.

Citizen science portals

iCoast of the USGS (USA)

National Universities

Cantabria, Alicante, Barcelona, Complutense University, UNED, UAM, UAB, USC, EHU, EXTREMADURA, CEIGRAM, Polytechnic University of Madrid; Universities of Vigo, Santiago and A Coruña, Murcia, Polytechnic of Cartagena, Las Palmas de Gran Canaria, La Laguna

Public organisms

INE, IECA, Eurostat, UNESCO University, Geoscience Australia, ESPON Observatory (EU), Council of Europe International Landscape Observatory, NOAA (USA), TROPOS (DE), WMO, EUBREWNET, PMOD / WRC, JRC / ISPRA, ACTRIS , CIEMAT, AEMET, GEO's Global Earth Observation System of Systems (GEOSS), European Drought Observatory; IEO

The collaboration with the mentioned Centers and with many others will be stimulated by the very nature of LIFEWATCH, which will organically connect research centers across the EU and promote collaborative science. Greater access to data will result in an improvement of the capacity of the participating entities to take part and develop international R & D & I projects.

International calls: H2020, Interreg ...

From the Governance Bodies of the INDALO Consortium, its members will be encouraged to develop international projects and participate in joint strategic transnational calls such as H2020 and its successors in the 2021-27 period.
INDALO will offer ERIC LIFEWATCH its participation as a partner in said Programs.

The Andalusian Agency of Knowledge and the Ministry of the Environment and Planning of the Territory will grant research grants expressly linked to the development of International Research Projects or Innovation, as well as the use of LW resources.

B2.6. Integration in environmental information networks

REDIAM is an integral part of the INDALO proposal, which is in fact led by the AMAYA Agency. The relationship of all the partners of INDALO with REDIAM is bidirectional: On the one hand they contribute contributing data and scientific results through the projects that the CMAOT finances.

On the other hand, they are nourished by the results of REDIAM's biodiversity observation through protocols and collaboration agreements that give them access to the data sources that this network manages, both the historical series and the data captured in real time by sensor networks located throughout the Andalusian territory.

REDIAM is coordinated with other structures of production and dissemination of information of environmental interest existing in the Administration of the Andalusian, State or international Board, among which are: the National Tele-Detection Plan and the National Plan of Aerial orthophotography, the Spanish Statistical and Cartographic System and that of Andalusia, the Spanish Inventory of Natural Heritage and Biodiversity.

It acts as an environmental thematic node of spatial data of the Spatial Data Infrastructure of Andalusia (IDEA) within the infrastructures and geographic information services in Spain and in coordination with the Statistical and Cartographic System of Andalusia, as well as the development and maintenance of the channels and services of the environmental information infrastructure of Andalusia.

REDIAM is part of the Spanish Inventory of Natural Heritage and Biodiversity and the Inventory Committee. The Spanish Inventory of Natural Heritage and Biodiversity is one of the instruments for knowledge and planning of the natural heritage and biodiversity. Through this participation the integration of the INDALO project in the IEPNB and the flow of data and exchange of information between both infrastructures will be ensured.

REDIAM is the network of services for environmental information for the development of the Spanish Inventory of Natural Heritage and Biodiversity within the Autonomous Community of Andalusia.

Likewise, REDIAM constitutes the focal point in Andalusia of the European Information and Observation Environment Network (EIONET (European Environment Agency).