PROPUESTA CIENTÍFICO-TÉCNICA RESUMIDA DE PROYECTOS COORDINADOS
Convocatoria 2021 - «Proyectos de Transición Ecológica y Transición Digital»

1. PORTADA

Datos de los subproyectos - *Subproject data (añada los que proceda)*

Subproyecto 1:

IP 1 Coordinador 1 (Nombre y apellidos)**: Jose Norberto Mazón López**

IP 2 Coordinador 2 (Nombre y apellidos)**: Esther Sebastián González**

Título - *Título*: Artificial Intelligence techniques to operationalize ecological indicators for the development of sustainable tourism in smart protected natural areas

Subproyecto 2:

IP 1 Coordinador 1 (Nombre y apellidos)**: José María Cecilia Canales**

IP 2 Coordinador 2 (Nombre y apellidos)**: Pietro Manzoni**

Título - *Título*: Designing a digital twin strategy for the sustainable development of smart protected natural areas

Título del proyecto coordinado (Acrónimo): Cambiando el turismo: estrategia de gemelo digital para el desarrollo sostenible de espacios naturales protegidos inteligentes a partir de indicadores ecológicos (CHAN-TWIN)

Title of the coordinated project (Acronym): Changing the tourism: a digital twin strategy for sustainable development of smart protected natural areas through ecological indicators (CHAN-TWIN)

2. PROPUESTA CIENTÍFICO-TÉCNICA RESUMIDA – *SUMMARY OF SCIENTIFIC AND TECHNICAL PROPOSAL*

Protected Natural Areas (PNAs) are places to be managed sustainably for the long-term conservation of their biodiversity and their promotion of both direct and indirect social benefits, which are grouped into four broad categories: ***environmental*** (e.g., related to local and global climate); ***ecosystemic*** (e.g., water quality and atmospheric gases control); ***social*** (e.g., recreation); and ***economic*** (e.g., development of business activities). Although PNAs are especially vulnerable to ***anthropogenic pressures*** such as Tourism or Agriculture, few ***digitalization procedures*** to ensure their sustainable development have been provided, which is essential for a continuous assessment of the ***interaction between ecological and social systems*** to foster ***biodiversity***, while ensuring the generation of wealth and jobs derived from the underlying ***economic activities***.

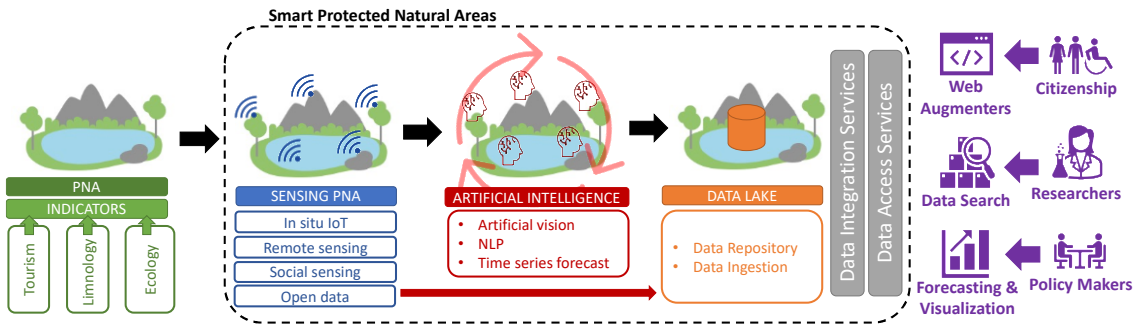

Figure 1 Overview of CHAN-TWIN Digital Twin Strategy for Smart Protected Natural Areas.

CHAN-TWIN focuses on ***changing the current tourism management model*** towards sustainability by developing a ***digital twin*** to build a systemic understanding of the ***socio-ecological inter-relationships*** affecting PNAs (see Figure 1). The *CHAN-TWIN* digital twin will address research challenges combining different ***sensing and modeling approaches*** to feed a data consumption pipeline, i.e., from raw input

data through data integration, to data analysis and visualization, thus providing information to ***different users***, including policy-makers, tourism managers or researchers.

Relation to the work programme (addressing ecological and digital transition)

The scope of the project is directly ***linked to both subtopics*** of the call, as stated in the following:

Addressing CSC (Call Specific Challenge) 1: *CHAN-TWIN* will develop data services for third parties to create applications to monitor the socio-ecological interplay of PNAs, ***combining ICT, ecological and social dimensions from the tourism viewpoint***. For showing the feasibility *of CHAN-TWIN* project, foundational ***web applications*** will be deployed for different kinds of users to consume produced data and get a more sustainable management of PNAs, making them more resilient to climate change and anthropogenic pressures from socio-economic activities.

Addressing CSC 2: *CHAN-TWIN* will provide an ***integrated approach*** that couples novel sensing technologies and innovative modelling of socio-ecological dynamics to forecast short and long-term changes in PNAs, thus supporting informed decisions to preserve ecosystem services that PNAs provide. This will be carried out by ***co-designing*** *CHAN-TWIN* digital twin with stakeholders, institutions and citizens, placed them in the center of the process.

Addressing CSS (Call Specific Scope) 1: *CHAN-TWIN* will combine different ***novel sensing technologies*** to measure ***socio-ecological variables***, with special emphasis in biodiversity and tourism indicators, to develop a ***sustainable tourism approach***, which provides insights in the socio-ecological tradeoffs for better management of PNAs.

Addressing CSS 2: *CHAN-TWIN* will generate ***scientific knowledge, develop disruptive technologies*** and ***support policy-making*** to promote sustainable tourism in PNAs**.** *CHAN-TWIN* will be ***application-driven*** based on the "Lagunas de la Mata y Torrevieja" Natural Park (Alicante, Spain), because its ecological value has been globally recognised and it is suffering an ecosystem deterioration, consequently having a negative impact on socioeconomic drivers, mainly tourism, which accounts for the largest share of the surrounding municipalities' GDP. In addition, this PNA is a ***challenging scenario*** from a technological point of view because of its large geographical spread (3.743 ha), which limits connectivity.

Methodology, objectives and coordination

CHAN-TWIN is divided into ***5 specific objectives*** that corresponds to 5 work packages (WP) that will be carried out by a ***subproject,*** which provides unique added value, bringing in experts in each of the research fields. The consortium will follow a ***participatory methodology*** among researchers and stakeholders (i.e., Action Research). The objectives, subproject and responsible PI are listed below:

Objective 1 [UPV; P. Manzoni]: Enable real-time tracking of socio-environmental data, obtained from different sources, including low-power sensors, social sensing and remote sensing using green information and communication technology (ICT).

Objective 2 [UA; E. Sebastián]: Develop new ML modelling approaches, which combine sensing data and AI techniques for the digitalization of ecosystem variables and functions to monitor ecosystem functioning in a PNA.

Objective 3 [UA; J.N. Mazón]: Develop a sustainable tourism approach based on an intensive use of data, which provides insights into the coupled socio-ecological dynamics to support better management of PNAs.

Objective 4 [UPV; J.M. Cecilia]: Enable real-time visualization, data integration, management and forecasting of the interplay between environmental and societal systems for sustainable tourism in PNAs.

Objective 5 [UPV/UA; Mazón & Cecilia]: Disseminate project outcomes through tailored activities and formats targeting key audiences (stakeholders, policy-makers, general public), including empowering existing networks to exchange knowledge, improving skills related to the use of *CHAN-TWIN* methodology, as well as increasing citizen awareness of environmental impacts.

Brief overview of experience and contributions of Principal Investigators

CHAN-TWIN-UA will be supervised by ***(1) Jose Norberto Mazón (main coordinator)***, associate professor at Department of Software and Computing Systems of the UA. He is director of UA's venue in Torrevieja where he created the Smart Tourism Lab (aiming to foster multidisciplinary research on IT and Tourism). His research expertise is about open data management, data integration and business

intelligence in big data scenarios and the design of data-intensive web applications. Moreover, he also has conducted multidisciplinary research on tourism intelligence and smart tourism destinations He was coordinator of the UA-Telefónica Research Chair in Use and Applications of Big Data. He has published more than 30 papers in high-quality journals such as Decision Support Systems or Current Issues in Tourism; and ***(2) Esther Sebastián,*** Ramón y Cajal fellow at the Ecology Department (UA). Her research interest lies in fields including wetland ecology, seed-dispersal and scavenger ecology, using tools such as network analysis or bioacoustics. Before joining the UA, she worked for 10 years as a postdoc in the University of São Paulo, in Stanford University, in the University of Hawaii, and in the Miguel Hernández University. She has authored 59 papers in JCR journals such as Global Change Biol, Global Ecol. Biogeogr. or Ecology. She has participated in 12 research projects (total funding > 5 million US$) of competitive calls (4 of them international), being the PI 3 times (total financing of projects where she was PI: € 346.105). She has also been part of 9 non-competitive contracts (3 times as PI).
CHAN-TWIN-UPV will be supervised by ***(1) José M. Cecilia (PI 1, UPV)***, Ramón y Cajal fellow at the Computer Engineering Department, UPV. His research interest lies in the convergence between emergent HPC and AI, following an application-driven approach where hardware and algorithmic innovations have been always considered to offer novel solutions to real problems. His research portfolio includes more than 60 JCR-indexed journals and 40 international contributions on high-quality international conferences in the area. He has supervised several national and international projects such as WATERoT, GLOBALoT under the call Retos-Colaboración and FET-H2020 SMARTLAGOON. It is important to note that all these projects are within the intersection between Computer and Environmental Science. The total budget Dr. Cecilia has managed in research and technology transfer projects with public funds is 943.983,59 €. Moreover, he has led up to 5 research contracts with different companies, in all of them as a PI, with a total budget of 142.249,5 €; and ***(2) Pietro Manzoni*** is full professor of computer engineering at UPV. He is the main coordinator of GRC group and senior member of IEEE. His research activity is related to the use of Mobile Wireless Networks to the design of dynamic systems. He is currently working on solutions for the Internet of Things focusing on LPWAN-based networks, and Pub/Sub systems. The overall focus is on the design of sustainable solutions, that is, solutions that try to consider at least one of sustainability's three main pillars: the economy, society, and the environment (these principles are also informally referred to as profit, people, and the planet) His research portfolio includes more than 115 JCR-indexed journals and 213 international conferences that have been highly cited (10.214, h-index 49 in Google Scholar).

Summary of socio-economic and scientific impact

CHAN-TWIN intents to advance the state of the art in computer science, ecology and tourism, both scientifically and technologically, while promoting the ***internationalization*** thanks to the European context in which the proposal is being developed. In the field of ***digitalization***, *CHAN-TWIN* aims to develop a digital twin strategy that promotes sustainable tourism, paving the way to managing ***smart PNAs*** and the optimal ecological state of their ecosystems. To this end, an energy-efficient computing strategy based on ***continuum computing*** will be developed, enabling the computation of data at different levels of the IoT infrastructure. Specifically, *CHAN-TWIN* will design (1) ***artificial vision -based sensors*** for monitoring, classification and census of different species of birds, (2) ***new IoT architectures*** with adaptive mesh-based and fault-tolerant topologies, using low-power and long-range connectivity protocols, covering the geographical and technological conditions of the PNAs, (3) ***data management procedures*** of socio-environmental data from different sources, including remote sensing strategies, social sensors, in-situ infrastructures and open data to generate a comprehensive data lake on the PNA's socio-environmental status, and (4) a ***service layer*** for the management of ecological and tourism data to ease the creation of data-driven products and services to foster the PNA's sustainability, considering the data lifecycle (acquisition, preparation and consumption).
These advances in the domain of digitalization will, in turn, enable breakthroughs in the ***ecological transition***. *CHAN-TWIN* will develop ***tourism sustainability indicators*** for smart PNAs, focusing on preserving the value of ecosystems, while optimizing the economic activity of the sector. Finally, *CHAN-TWIN* will establish a co-creation process with different institutions, organisations and citizens to raise public awareness on the relevance of preserving our natural resources through participatory events, and open innovation initiatives, which will enable the steady transition towards sustainable manage of socio-economic activities affecting natural resources.