Climate change REsilience framework for health

SYStems and hospiTALs

DD1.1: [Monitoring Methodology]	
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Executive summary

This deliverable is produced as part of action D.1 "*Development of a common monitoring methodology*" of the RESYSTAL project.

Within this document, RINA-C have developed a **common monitoring methodology** to allow proper evaluation of the project actions and their expected results along the project duration and beyond.

The methodology is designed at **pilot scale/level** (Table 1) and based on the climate change adaptation interventions that the single hospital plan to install, according to the climate hazard in their region, the available budget, etc.

Table 1: LIFE RESYSTAL Pilot Hospitals

Country	City	Involved hospitals	Technical Supporting Partner
France	Millau	Hospital Center of Millau: - Hospitals of Millau - Hospital of Saint-Affrique	ACTERRA
Spain	Ourense	Galician Health Service (SERGAS): - University hospital of Ourense - Public hospital of Verin - Public hospital of Valdeorras	ACTERRA
Greece	Athens	Nikaia General State Hospital (NHOSP)	National Center for Scientific Research Demokritos (NCSRD)
Italy	Bari	University hospital complex: - Polyclinic of Bari - Giovanni XXIII hospital	RINA - C

The **Key Performance Indicators (KPIs)**/parameters identified within the methodology to monitor the progress of the hospital in term of climate change adaptation for the entire duration of the project, cover climate, environmental, social, economic and political aspects.

The proposed KPIs list within this deliverable (Common Monitoring Methodology chapter) consist in a preliminary foundation for further consideration along the all project life (to 2025) and the list will be constantly updated during the duration of the project and finalized in Action D.4 "*Following of the LIFE key project indicators*". In particular, as indicated in DA1.4 "*Monitoring committees set up in each pilot*" led by ACTERRA, a near-final or more accurate list of the KPIs proposed here will be approved by each hospital's monitoring committee during 2nd plenary meeting of CoPs (around June 2022).

In order to maximize the applicability and consistency of the methodology with real operational practice of health systems, the methodology will be **validated by the pilots** in the context of the Community of Practice (CoP), in particular - through interviews or questionnaires and by the **monitoring committees**, which is composed with one or more members of the hospital staff dedicated to the project activities, established in A1.3 (for more details see DA1.4 "*Monitoring committees set up in each pilot*").

The developed methodology has been developed so that it can be suitable to be used in **other hospitals** than the LIFE RESYSTAL pilots as well as to catch the effects of different types of hard and soft adaptation measures.

This deliverable is intrinsically **connected with** the second deliverable of action D1 therefor deliverable **DD1.2** "*Physical Monitoring Design*" which provide an overview about the measurement equipment/sensors used in the evaluation of the KPIs identified in deliverable DD1.1.

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Table of abbreviations	
Abbreviations	**Meaning**
CAM	Minimum Environmental Criteria
CCA	Climate Change Adaptation
CoP	Community of Practice
CSS	Carbon Storage and Sequestration
GHG	Greenhouse Gases
H&C	Heating and Cooling
HCWHE	Health Care Without Harm
HSE	Health, Safety and Environmental
KoM	Kick-off Meeting
KPIs	Key Performance Indicators
M&E	Monitoring & Evaluation
NCSRD	National Center for Scientific Research Demokritos
NGO	Non-Governmental Organization
NHOSP	General State Hospital of Nikaia “Agios Panteleimon”
NICU	Neonatal Intensive Care Unit
O&M	Operation & Maintenance
PCAET	Local Climate, Air and Energy Action Plan
POLIBARI	University hospital complex of the polyclinic of Bari and the Giovanni XXIII hospital

1. Introduction

The following sections describe the scope and the structure of the current deliverable, as well as the interdependencies with other LIFE RESYATAL tasks and deliverables.

1.1 Scope of the Deliverable

The activities contained in this deliverable aim to construct the system architecture and specifications as a guide towards the **evaluation of project actions** and their expected results along the project duration, at the end of the project and beyond (three or five years after the project).

In particular, RINA developed a **monitoring methodology** at pilot scale on climate, environmental, social, economic and political aspects which will be used in the 4 years of the project to measure the progress in the adaptation on climate change of the 7 pilot hospitals.

In fact, the activities reported in this Deliverable will drive the monitoring activities of the project (Action D3 and D4).

1.2 Structure of the Deliverable

Within this Deliverable, besides Chapter 1 that constitutes the present Introduction, the following sections are included:

- **Chapter 2** outlines the methodological approach;
- **Chapter 3** presents developed a pilot scale methodology in term of indicators to collect, monitor and measure the project progress on the climate change adaptation capacity of the hospitals;
- **Chapter 4** draws the conclusion remarks and next steps.

1.3 Interdependencies with Other Tasks and Deliverables

The activities contained in this deliverable aim to construct the system architecture and specifications as a guide towards the evaluation of project actions and their expected results along the project duration, at the end of the project and beyond (three or five years after the project).

The activities reported in this Deliverable will drive the monitoring activities of the project (Action D3 and D4) and have been performed in strictly collaboration with **Action A** "*Preparatory actions"*, led by the partner ACTERRA.

Action A1

RINA activities linked with Action A1, led by ACTERRA and named "*Building of climate resilient healthcare Communities of Practice (CoP*)" can be mainly summarized as the following:

- A1.1 *Mobilisation of local stakeholders to build site-level Communities of Practice (M1-M3)*

    1) Based on the mapping of stakeholders proposed by each pilot, ACTERRA established a generic reference model of stakeholders contributing to the pilot hospitals' climate resilience. Then,

ACTERRA built a **stakeholder map** for each hospital which contain a variety of profiles such as: interested hospital departments, professional from hospitals, first responders, external critical infrastructure managers, local health authorities, climatologists, local authorities and agencies, engineers, investors, health scientists, etc;

RINA-C supported **PoliBari** pilot hospital for the identification of the stakeholders to propose to ACTERRA.

For more detail please see the project's submitted deliverable DA1.1 "*Stakeholders' Matrix"*.

2) Based on the stakeholder maps, ACTERRA established a Community of Practice (**CoP**) for each hospital, as an exchange platform, where contributors of the community share their knowledge, their personal and professional experience on the climate change and health challenges and solutions. The community has the overarching goal to engage stakeholders from the hospital and beyond (critical infrastructure, climate authorities, local authorities) to build a collective climate-resilient pathway for the hospitals.

RINA-C supported **PoliBari** pilot hospital in the establishment of its **CoP**, starting from the organization of its **kick-off meeting** as a first involvement of hospital internal and external stakeholders.

For more detail please see the project's submitted deliverable DA1.3 "*CoP charter"*.

The CoP will support/be involved in RINA monitoring & evaluation activities for the following objectives (Table 2):

Table 2: Community of Practice activities related to RINA M&E work

Topics	Facilitate data collection and ensure that project output meet expectations at hospital scale	Ensure the buy-in of local stakeholders and endorsement of adaptation strategy	Monitor the progress of the hospital's adaptation process
Monitoring & Evaluation (M&E)	Outcome: Relevant indicators are identified Role of the CoP: Review and approve the indicators	Outcome: Indicators are mainstreamed into the hospital's M&E system Role of the CoP: Facilitate the endorsement of monitoring indicators by hospital management	Outcome: Adaptation actions are regularly monitored Role of the CoP: Organize yearly meetings to assess progress

The Kick-off Meeting of the CoPs have been carried out by during the months of December 2021 and January 2022. The specific timeline is shown in the following table (Table 3).

RINA prepared and conducted the KoM for the Italian pilot (PoliBari).

Table 3: Date of Community of Practices' Kick off Meeting

Country	City	Involved hospitals	Kick off Meeting of CoP
France	Millau	Hospital Center of Millau: - Hospitals of Millau	13th January, 2022

Country	City	Involved hospitals	Kick off Meeting of CoP
		- Hospital of Saint-Affrique	
Spain	Ourense	Galician Health Service (SERGAS): - University hospital of Ourense - Public hospital of Verin - Public hospital of Valdeorras	18th January, 2022
Greece	Athens	Nikaia General State Hospital	17th December, 2021
Italy	Bari	University hospital complex: - Polyclinic of Bari - Giovanni XXIII hospital	24th January, 2022

- A1.2 *Pilot cases' knowledge sharing and capacity assessment*

In order to understand the current status/situation of the hospitals in term of Leadership, Governance and Data, Buildings and Infrastructure and Emergency Preparedness, ACTERRA developed a **capacity assessment survey** in excel form and distribute it to each pilot hospital.

RINA-C collaborate in the draft of the survey and integrated it with questions/ considerations on frequency, role, instrument of the single parameter for *Leadership, Governance and Data* aspects and, in particular, in the sections *Leadership and Organizational Capacity to Build Climate Resilience* and *Mechanisms to Collect and Monitor Climate Data*.

More details about the methodological approach and the survey's results can be found in DA1.2 *"Capacity Assessment matrix"* lead by ACTERRA.

Action A2 and Action A3

RINA monitoring activities in action D1 are directly linked with sub-activities of Action A2 "*Preparatory actions for pilot case assessment and adaptation*" and Action A3 "*Local toolbox functional requirements*" as shown in the following figure (Figure 1).

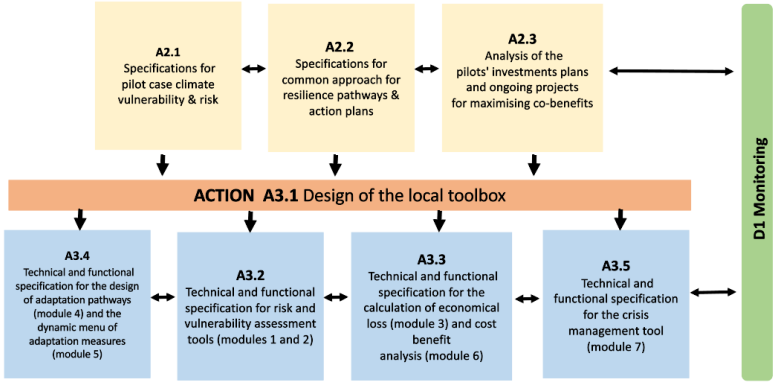

Figure 1: RINA work interlinks with Action A2 and A3

In particular, RINA-C identified some KPI related to "Training activities" for *communication, dissemination, awareness rising* objective concerning topics on the following seven modules, which will be part of the

toolbox designed as an adaptation planning web-based Decision Support System covering short, medium and long-term climate change risk assessment by NCSRD in Action 3.1.

2. Methodological Approach

Based on the interdependencies with ACTERRA's activities above specified, RINA's work methodology leading up to the writing of this deliverable included:

- Examination of the results of the ACTERRA A1.3 **capacity assessment survey** regarding the presence of monitoring systems, inserted by RINA in the sections *Leadership and Organizational Capacity to Build Climate Resilience* and *Mechanisms to Collect and Monitor Climate Data*;
- Participation in periodic **technical partner** meetings organized by Demokritos (for action linked with the design of the local toolbox i.e. A3, C1, C2, C3, etc.), for a comparison and alignment between technical partners;
- Organization of **specific meetings** with the responsible people of the four complex hospital for their feedback on the monitoring KPIs list and KPIs validation. The timeline of these meetings is shown in the following table (Table 4).

Table 4: Date of monitoring KPIs' review meeting

Country	City	Involved hospitals	Review monitoring KPIs
France	Millau	Hospital Center of Millau: - Hospitals of Millau - Hospital of Saint-Affrique	22nd December, 2021
Spain	Ourense	Galician Health Service (SERGAS): - University hospital of Ourense - Public hospital of Verin - Public hospital of Valdeorras	28th January, 2022
Greece	Athens	Nikaia General State Hospital	21st December, 2021
Italy	Bari	University hospital complex: - Polyclinic of Bari - Giovanni XXIII hospital	3rd December, 2021

Moreover, the methodology includes mainly the following steps for data collection, monitoring and measurement:

1. **Collection of data** from:
- Hospitals: synchronizing the work with what will be done by NCSRD per la sub-action A2.1 named "*Specifications for pilot case climate vulnerability and risk assessment"* (M4-M10) which aim to collect, organize and synthesize the available information concerning climate adaptation potential of each hospital;
- End-users (patients);
- Local stakeholders related to each pilot hospital: synchronizing the work with what has been done by ACTERRA in A1.1 "*Stakeholders' mapping";*
- Satellite and meteo data related to specific region;
- Monitoring equipments.

2. **Monitoring technologies** (part of the second deliverable DD1.2 of Action D1 named "*Physical Monitoring Design"*):

- Support to pilot hospitals in the identification of the monitoring technologies (e.g.: sensors, monitoring stations, data acquisition system, etc);
- Installation of these technologies by pilot hospitals.

The technical support provided by RINA will mainly involve University hospital complex of PoliBari and will be carried out throughout the whole duration of the project.

3. **Protocol for monitoring** (partially part also of DD1.2 of Action D1 named "*Physical Monitoring Design"*) including:

- frequency of parameter monitoring;
- role of person responsible/stakeholder actor for monitoring;
- how parameters will be monitored (i.e.: manually or automatically);
- where monitored parameters will be stored (archived in a dedicated record book, as electronic spreadsheet, etc.).

Finally, in order to maximize the applicability and consistency of the methodology with real operational practice of health systems, the methodology will be validated by the pilots in the context of the Community of Practice (CoP), in particular - through interviews or questionnaires and by the **monitoring committees**, which is composed with one or more members of the hospital staff dedicated to the project activities, established in A1.3 (for more details see DA1.4 "*Monitoring committees set up in each pilot*").

3. Common Monitoring Methodology

The proposed pilot specific method is based on the intervention that the single hospital plan to develop, according to the baseline assessments described in the following table (Table 5).

Table 5: Pilot hospitals' intervention plan for climate change adaptation

Pilot hospital	Country	Technical Supporting Partner	Item	Location
Azienda ospedaliera universitaria consorziale policlinico di Bari e ospedale Giovanni XXIII	Italy	RINA-C	Green walls	Hospital buildings walls and facades
	Italy	RINA-C	Lawn	In the area of the hospital
	Italy	RINA-C	Trees	In the overall vicinity of Polibari
	Italy	RINA-C	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	Inside and around the building where the heating and cooling system will be used
Nikaia General Hospital (NHOSP)	Greece	Demoktritos	Heating and cooling system	In a building (5 floor) that contains 6 department: A' cardiology, B' cardiology, gynecology, pediatric, pediatric surgery, neonatal NICU. Specifically, it will be installed in neonatal NICU that lacks a cooling and heating system that provide fresh air alongside a stable temperature conditions.
	Greece	Demoktritos	Lawn	in the entrance area of the hospital
	Greece	Demoktritos	Trees	In the overall vicinity of NHOPS
	Greece	Demoktritos	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	Inside and around the building where the heating and cooling system will be used
CH Millau	France	ACTERRA	Green roof	On the "Puits de Calès", the main building of the hospital, where the architecture (pyramidal roof-terrace construction) is compatible
	France	ACTERRA	Trees	Depending on the results of feasibility study
	France	ACTERRA	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	Inside and around the building where the heating and cooling system will be used
CH Saint Affrique	France	ACTERRA	Trees	In the overall vicinity of the hospital
	France	ACTERRA	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	Inside and around the building where the heating and cooling system will be used
Sergas: Hospital Universitario de Ourense	Spain	ACTERRA	Green walls	Hospital buildings walls and facades
	Spain	ACTERRA	Green corridor	Hospital surrounding, connecting the different hospital buildings
	Spain	ACTERRA	Rainwater collection and utilization system	To be installed in the vicinity of the hospital and used for the irrigation system of green corridors and green walls
	Spain	ACTERRA	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	It will be installed at the hospital (to be further refined). Real time monitoring system with sensors, acquisition, database and generation of alerts and trends (if requires PC, software, hubs and sensors)
Sergas: Hospital Publico de Verin	Spain	ACTERRA	Green walls	Hospital buildings walls and facades
	Spain	ACTERRA	Green corridor	Hospital surrounding, connecting the different hospital buildings
	Spain	ACTERRA	Rainwater collection and utilization system	In the vicinity of the hospital and used for the irrigation system of green corridors and green walls
	Spain	ACTERRA	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	It will be installed at the hospital (to be further refined). Real time monitoring system with sensors, acquisition, database and generation of alerts and trends (if requires PC, software, hubs and sensors)
Sergas: Hospital Publico do Barco de Valdeorras	Spain	ACTERRA	Green walls	Hospital buildings walls and facades
	Spain	ACTERRA	Green corridor	Hospital surrounding, connecting the different hospital buildings

Pilot hospital	Country	Technical Supporting Partner	Item	Location
	Spain	ACTERRA	Rainwater collection and utilization system	In the vicinity of the hospital and used for the irrigation system of green corridors and green walls
	Spain	ACTERRA	Monitoring materials: climate adaptation monitoring station, two for the hospital, IT devices, PCs, data storage.	The installation will be further refined. Real time monitoring system with sensors, acquisition, database and generation of alerts and trends (if requires PC, software, hubs and sensors)

Moreover, the following **pilot hospital characteristics** have been taken into account, based on data provided by pilots in the baseline assessments (Table 6):

Table 6: Hospitals' data and information

Topics	Local informations	NHOSP	POLIBARI	CH Millau	Saint- Afrique	Hospital Universitario de Ourense	Hospital publico de Verin	Hospital Publico do Barco de Valdeorras
General informations	Geographical context	Urban area	Urban area	Rural area	Rural area	Semiurban + Rural	Rural	Rural
	Mean annual budget (mil euro)	15	280	80	30	400		
	Type and creation year	1937 cement based	1930	1887-2012	1930-1980	60's-2017	1994	1978-2020
	Building and campus area (m2)	44877-42269	23000	37745	9,5	61	22	16
	N. buildings	33	32	20		7	1	1
	N. beds	620	1550	463	236	925	80	100
	N. hospitalisations	620	15000	11192		29958	258	3236
	Specific needs	\	Sustainable operations	New buildings and sustainable operations for old infrastructures		\	\	\
Technical informations	Air conditioning system	Y	Y	Y	Y	Y	Y	Y
	Emergency generator	Y	Y	Y	Y	Y	Y	Y
	Other emergency backup systems	N	N	N	N	N	N	N
	Warning system against climate hazards	N	N	N	N	N	N	N
Climate problem	Potential physical risk	Heat waves	Heat waves	Heat waves	Floos	Flood, heat waves, fire	Flood, heat waves, fire	Flood, heat waves, fire
	Potential impact	Air conditioning (A/C) system exceed the operation parameters and stop working	Air conditioning system exceed the operation parameters and stop working. Threat medicaments' conservation	Air conditioning system exceed the operation parameters and stop working. Threat medicaments' conservation	Floodable zone	Some sensitive areas without A/C. Flood risk at basements. Fire in rural areas. Deplacement of patients	Fire in rural areas. Deplacement of patients	Fire, flood, deplacement of patients
	N. patients at risk	150	150	300	240	\	\	\
	N. and type of buildings at risk	30 - Administrative, clinics, ER, supporting infrastructures	30 - Administrative, clinics, operations	6 - Clinics, EPHAD	3 - Clinics, EPHAD	2 - Clinics, administrative hospitalisation	\	\

Topics	Local informations	NHOSP	POLIBARI	CH Millau	Saint- Afrique	Hospital Universitario de Ourense	Hospital publico de Verin	Hospital Publico do Barco de Valdeorras
	Type of critical infrastructures at risk	Power stations, chillers, air handling units, medical air production systems, boiling rooms, NG distribution system	Power stations, boiling rooms, medical air production systems	Power stations, boiling rooms, medical air production systems	\	\	\	\
	Part of budget dedicated to Climate Change	0	0	0	0	0	0	0
	Climate Change maturity	Low	Low	Medium	Medium	Medium	Medium	Medium

Based on the above information/data, RINA prepared a list of **Key Project Level Indicators** which can be used to evaluate the hospital status and progress in term of adaptation on climate changes, as well as future possible replication in hospital/health system other than the LIFE RESYSTAL project pilot hospitals. Moreover, inside LIFE RESYSTAL project, these parameters will help to evaluate actions and their expected results along the project duration, at the end of the project and beyond (three or five years after the project).

The proposed KPIs list within this deliverable consist in a **preliminary foundation** for further consideration along the all project life (to 2025) and the list will be finally updated in Action D.4 "*Following of the LIFE key project indicators*".

Table 7: List of common KPIs

Objectives	Indicators	
Improved Environmental and Climate Performance (including resilience to climate change)	Green and Blue infrastructure	Hectars of green (i.e. tree planting, rewilding of lawns, green roof/walls, absorbent parks) and blue (i.e. rivers, canals, ponds, wetlands, floodplains, water treatment facilities, sustainable urban drainage systems) infrastructures created
	Climate hazards - Infrastructure resilience	Total hospitalized patients in buildings at risks (see Table 6: Hospitals' data and informationTable 6)
		Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients
		Buildings with improved resilience thanks to Green and Blue infrastructure (see Table 0.2 Hospitals' data and information)
	Climate hazards - Flooting	Hectars (improved conditions)
		Runoff reduction thanks to Green, Blue and Grey infrastructure
	Air - Improved resilience to heat waves	Temperature air reduction from green roofs and facades outdoor
		Temperature air reduction from green indoors (i.e.: walls, corridors and facades)
		Temperature of external air reduction from tree planting
	Climate co-benefits	Carbon sequestration from tree planting
		Reduction of heat island effect through green infrastructure
		Air pollution removal (PM10 and O3)
Better use of resources	Energy	Reduced energy consumption
		Energy produced from renewable
		Monitoring of the energy savings due to the improvement of the existing air conditioning systems
	Food	Meal with locally and sustainably food on total meal served
	Waste	Waste reduction program (e.g: reuse bags, organics recycling, training, compost food waste etc.) and consequent financial saving

Objectives	Indicators	
		Quantity of waste reduction during the project according to waste reduction program, detailed for waste cathegory (hazardous, non hazardous)
Social, Political and Economic Performance, Market Uptake, Replication	Employment	New jobs created (full time employee)
	New infrastructure	Investments in blue-green and grey infrastructures
	Replication / Transfer	Hospital/health system using Upscaling Adaptation Starting Package (UASP) in the country
	Guidance and tools	Training/capacity building activities about: system-approach developed, capacity building programmes designed, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at integrating health and climate policy
Communication, dissemination, awareness rising	Awareness raising	Stakeholders engaged
		Entities/individuals reached/ made aware
		People trained to modules 1 to 6 of A3.1 (page 49 proposal)
		People trained to module 7 of A3.1 (page 49 proposal)
		Articles produced
		Workshops and events organized
	Website	Visitors per month
	Behavioural change	Entities/individuals changing behaviour as a result of their engagement in the project

Finally, monitoring aspects are also investigated within the adaptive capacity assessment survey developed for DA1.2. For more details see DA1.3 "*Community of Practice for Climate Resilience Healthcare Facilities' Engagement Charter*" and DA1.2 "Capacity Assessment matrix" for the survey's results.

RINA has detailed the above table at **pilot scale level** and for each identified parameters RINA has specified:

- the unit of measurement;
- the monitoring frequency;
- the monitoring device (described in more details in DD1.2);
- the role of the person/actor responsible for monitoring;
- hospital comment, following the review meetings (see Table 4: Date of monitoring KPIs' review meeting).

In addition, is present "Data Source and RINA Hypothesis" column containing RINA's assumptions relative to the subject and the sources from scientific literature for the calculation of the indicators in question.

The following four sections show the customization of monitoring parameters for the four pilot hospital complexes.
RINA identified as "Technical department" per example the following actors:

- Engineering service;
- Operation & Maintenance (O&M) responsible, on-site technician;
- Health, Safety and Environmental (HSE) manager;
- Prevention and Protection Service Manager (RSPP).

And with "Hospital personnel", for example the following actors:

- management;
- medical staff;
- support staff.

How the parameters will be monitored (i.e.: manually or automatically) and where the monitored parameters could be stored (stored in a dedicated record book, as a spreadsheet, etc.), through contact

with the actors identified above (i.e.: hospitals, stakeholders, other LIFE RESYSTAL project partners, etc.) will be described in the second deliverable of the current task DD1.2 "*Physical Monitoring Design*".

3.1 Azienda ospedaliera universitaria consorziale policlinico di Bari e ospedale Giovanni XXIII

Please note that:

- indicators marked with (**) could potentially be monitored right away – at the start of the project;
- indicators marked with (*) would require the purchase of appropriate equipment as the one described in DD1.2 "*Physical Monitoring Design*", which is not already installed in the pilot hospitals (as per interviews with the various hospitals).

Table 8: List of KPIs for Azienda ospedaliera PoliBari

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
Improved Environmental and Climate Performance (including resilience to climate change)	Green and Blue infrastructure	Hectars of green (*i.e. tree planting, rewilding of lawns, green roof, absorbent parks*) and blue (*i.e. rivers, canals, ponds, wetlands, floodplains, water treatment facilities, sustainable urban drainage systems*) infrastructures created (*)	m2/ha	6 month/ yearly	Laser distance meter of green area covered – Manual	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks N. 10 trees correspond to 100 m2 of green infrastructures	Green infrastructures: - Green areas present and large with different types of planting, implementable in adjacent parking - Green roofs not present at the moment and difficult to implement because of the presence of machinery on the roofs of the buildings - Green corridors implementable Blue infrastructures: Not planned because less feasible measures (e.g.: example a water storage tank) for contamination issues and conflict with underground services Considering 4 year project, investigate if also existing infrastructure have to be kept in consideration.
	Climate hazards - Infrastructure resilience	Total hospitalized patients in buildings at risks (*see Table 0.2 Hospitals' data and information*) (**)	N.	yearly	Medical electronic record - Manual	-Hospital personnel -IT Dep. -Administrative Dep.	Needed for the percentage below	\
		Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients	%	yearly	Survey - Manual	-Hospital personnel -Stakeholders to facilitate communication with patients -IT Dep.	Impact in % estimated compared to the whole number of yearly hospitalized patients.	To be defined the entity for the preparation of the brief survey (maximum 5 questions). To be defined the analysis' boundary (e.g.: within the health system Consultation Committee Mixed (CCM), external handicap people association, etc.)
		Buildings with improved resilience thanks to Green and Blue infrastructure (*see Table 0.2 Hospitals' data and information)*	N. or %	6 month/ yearly	\	Technical Department	Impact in % estimated compared to the whole number of buildings at risks	Only green infrastructures are planned to be implemented

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
	Climate hazards - Flooding	Hectars (improved conditions) (*)	ha	6 month	Laser distance meter of green area covered – Manual	Technical Department	Assuming that tree planting, rewilding and green corridors infrastructures contribute to improved flooding resilience	Possible merge with similar indicators
		Runoff reduction thanks to Green and Blue (*)	%	6 month/ yearly	Water flow sensors or balancing tanks – Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	To be monitored before and after (similar season/rainwater frequency) the implementation of green and blue (e.g: water storage, infiltration basin, dry proofing) infrastructures
	Climate hazards - Heat waves (Air)	Temperature air reduction from green roofs and facades outdoor	°C	6 month	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer- Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	To be monitored before and after (similar season/heat waves frequency) the implementation of green and blue (e.g.: see above) infrastructures.
		Temperature air reduction from green indoors (i.e.: walls, corridors and facades)	°C	6 month		Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	To be monitored before and after (similar season/heat waves frequency) the implementation of green and blue (e.g.: see above) infrastructures.
		Temperature of external air reduction from tree planting (*)	°C	6 month		Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	To be monitored before and after (similar season/heat waves frequency) the implementation of green and blue (e.g.: see above) infrastructures.
	Climate co-benefits	Carbon sequestration from tree planting	kg CO_2	6 month/ yearly	\	Technical Department	Carbon Storage and Sequestration (CSS) by urban trees in the USA: *https://www.sciencedirect.com/science/article/abs/pii/S0269749101002147* How to calculate the amount of CO2 sequestered in a tree per year:*http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf*	Calculated by RINA, based on the number and type of trees planted. The calculation is performed by considering an average net carbon sequestration annual value for a tree, and associated carbon dioxide amount. Then, the factor obtained is multiplied by the minimum number of trees expected to be planted in each pilot.
		Reduction of heat island effect through green infrastructure (*)	°C	6 month/ yearly	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer- Automatic	Technical Department	The Impact of Green Areas on Mitigating Urban Heat Island Effect: *https://www.researchgate.net/publication/271206461* Temp. reduction in a treed urban environment can reach up to 4° C and it depends on the size of the park, amount of trees and grass cover in the park and choice of species. Street trees	Possible merge with n.11 and n.13 rows

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
							could influence air temp. significantly	
		Air pollution removal (PM_{10} and O_3) (*)	kg	6 month/ yearly	Monitoring stations – Automatic	Technical department/ Regional authorities (es. Legambiente, Municipality of Bari)	Air pollution removal factors for deciduous broadleaved trees: O_3 0.0310 t/ha/y; PM_{10} 0.0176 t/ha/y https://www.sciencedirect.com/science/article/pii/S2210784316300997 Assuming 1 year effects of green outdoor measures during the project, based on the project timeline	Can be calculated by RINA, based on the number of green outdoor measures.
Better use of resources	Energy	Reduced energy consumption	%	monthly	Energy bills, meter - Manual	Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: https://www.nrel.gov/docs/fy10osti/47867.pdf	Depending on the new grey (e.g. adaptation of heating and cooling system with the substitution of chillers/equipments) measures implemented or change of functional parameters of existing infrastructured which lead to a reduction in the energy consumption
		Energy produced from Renewable (**)	kwh	yearly		Technical Department	The indicator also includes purchase of electricity from supplier that produces energy from renewable sources or not.	Solar/photovoltaic panels currently not present in the hospital complex, perhaps implementable during the project.
		Monitoring of the energy savings due to the improvement of the existing air conditioning systems	kwh	monthly		Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: https://www.nrel.gov/docs/fy10osti/47867.pdf	\
	Food	Meal with locally and sustainably food on total meal served (**)	%	yearly	\	Catering company	https://climatecouncil.noharm.org/	PoliBari has a new external service catering, selected based on Minimum Environmental Criteria (CAM) through environmental criteria in the tender.
	Waste	Waste reduction program (e.g: reuse bags, organics recycling, training, compost food waste etc.) and consequent financial saving (**)	N. Euros	yearly	\	Technical Department	According to 'https://climatecouncil.noharm.org/ waste management represents 1-5% of U.S. GHG emissions and hospitals produce an average of 30 pounds of waste per patient/day	\

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		Quantity of waste reduction during the project according to waste reduction program, detailed for waste cathegory (hazardous, non hazardous) (**)	tons	yearly	\	Technical Department	\	\
Social, Political and Economic Performance, Market Uptake, Replication	Employment	New jobs created (full time employee) in the project (**)	N.	6 months	HR Registers	HR Dep.	Based on the staff ("Additional staff" to be hired in the project (see proposal – F Part – F1)	\
	New infrastructure	Investments in blue-green and grey infrastructures	euros	6 months	Business plan	Technical Department Financial resource dep.	Calculation of the investments in Infrastructures costs (see proposal – F Part – F4a F4b)	\
	Project Results' Replication / Transfer	Hospital/health system using "Upscaling Adaptation Starting Package (UASP)" in the country	N.	end of project	\	Financial resource dep. Administrative Dep.	Replication/transfer of project results secured through the work of " *Scaling Network and Facilitation Board*", will be monitored, thanks to RINA-C's involvement in Action C5.3 (M37-M48). Hp: one hospital/health system already using "Upscaling Adaptation Starting Package (UASP)" - *provided in open source on the project website* - at the end of the project (one in the country of each pilot).	\
	Guidance and tools	**Training**/capacity building activities about: *system-approach developed, capacity building, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at integrating health and climate policy*	N.	3 months	Attendance registers (training)	Communication De./ Information office	At the end of the project the number of guidance and tools is expected to be > 3	Training of medical staff and patients. Dissemination also through leafleting (in notice boards introduction in common hospital spaces) Possible merge with rows n. 29 and n. 30

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
Communication, dissemination, awareness rising	Awareness raising	Stakeholders engaged	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: CoPs=105 members Facilitation Board=20 members Scaling network=30 members WHO, WGIN and others = 10 people	To be planned within project partners To be defined: what to share with stakeholders about the project and the engagement method
		Type of entities/individuals reached (made aware)	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: 210 hospitals, 10 investors 175 managers and authorities 10 National/EU policy makers 10 insurance companies 50 building/civil engineering companies 50 experts of blue-green infrastructures, renaturation, CC and biodiversity 7000 general public (1000 people/hospital)	To be planned within project partners
		People trained to modules 1 to 6 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 15 people per pilot hospital	To be defined if training to medical staff, patients or both, considering the technicality of the training material
		People trained to module 7 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 10 people per pilot hospital	To be defined if training to medical staff, patients or both, considering the technicality of the training material
		Articles produced in itinere on the project	N.	3 months	Excel file	Communication De./ Information office	See proposal – Part B – B4	\
		Workshops and events organized	N.	3 months	Excel file	Communication De./ Information office	1 workshop per hospital 1 workshop organised by UCAM 2 workshop organised by HCWHE 5 webinars of the Scaling Network 3 webinars of the Facilitation Board 1 Optimisation workshop/pilots	To be planned within project partners
	Website	Visitors per month (**)	N.	monthly	Webinar click software	IT Department	Based on usual numbers, average number reached starting from M12 (after some engagement activities)	\
	Behavioural change	Entities/individuals changing behaviour	N.	3 months	webinar, interview, survey	Communication De./ Information office	Assumption: 80% of stakeholders engaged	To be defined the type of behaviour to be investigated

3.2 Nikaia General Hospital NHOSP

Please note that:

- indicators marked with (**) could potentially be monitored right away – at the start of the project;
- indicators marked with (*) would require the purchase of appropriate equipment as the one described in DD1.2 "*Physical Monitoring Design*", which is not already installed in the pilot hospitals (as per interviews with the various hospitals).

Table 9: List of KPIs for Nikaia General Hospital

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
Improved Environmental and Climate Performance (including resilience to climate change)	Green and Blue infrastructure	Hectars of green (i.e. tree planting, rewilding of lawns, green roof, absorbent parks) and blue (i.e. rivers, canals, ponds, wetlands, floodplains, water treatment facilities, sustainable urban drainage systems) infrastructures created (*)	m2/ ha	6 month/ yearly	Laser distance meter of green area covered - Manual	Engineering Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks N. 10 trees correspond to 100 m2 of green infrastructures	There are already (a few) green areas and other green infrastructures will be implemented (lawn in the entrance area of the hospital and tree planting). Blue measures are not planned to be implemented. Considering 4 year project, investigate if also existing infrastructure have to be kept in consideration
	Climate hazards - Infrastructure resilience	Total hospitalized patients in buildings at risks (*see Table 0.2 Hospitals' data and information*) (**)	N.	yearly	Medical electronic record - Manual	-Hospital personnel -IT Dep. -Administrative Dep.	Needed for the percentage below	The number is almost constant:400 total hospitalize patients and 700 beds maximum (if more people come to the emergency room, they are moved to other hospitals)
		Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients	%	yearly	Survey - Manual	-Hospital personnel -Stakeholders to facilitate communication with patients -IT Dep.	Impact in % estimated compared to the whole number of yearly hospitalized patients.	Suggestion to modify the indicator. It seems not easily measurable and it could not describe much on the improvement related only to project interventions (many other factors could improve the health). Moreover, an health assessment would take long time (decades, outside of 4 year project).
		Buildings with improved resilience thanks to Green and Blue infrastructure (*see Table 0.2 Hospitals' data and information)*	N. or %	6 month/ yearly	\	Engineering Department	Impact in % estimated compared to the whole number of buildings at risks	No green roof will be implemented in the hospital, not applicable

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
	Climate hazards - Flooding	Hectars (improved conditions) (*)	ha	6 month	Laser distance meter of green area covered - Manual	Engineering Department	Assuming that tree planting, rewilding and green corridors infrastructures contribute to improved flooding resilience	Possible merge with similar indicators
		Runoff reduction thanks to Green and Blue (*)	%	6 month/ yearly	Water flow sensors or balancing tanks – Automatic	Engineering Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	Useful indicator if the hospital has flooding as potential physical risk. NHOSP hospital is subject to flooding due to construction problem (not climate/weather reason) because under the hospital there is a river which create problems in case of heavy rain or river flood. In particular, in the second basement the system is made from two already installed heat pumps that monitor the water from the river preventing from flooding. The monitoring is not done from distance/remotely but people have to go physically to the basement. This prevention system in use (grey, not green) works for business as usual situation.
	Air - Improved resilience to heat waves	Temperature air reduction from green roofs and facades outdoor (*)	°C	6 month	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer - Automatic	Engineering Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	No green roof or facades will be implemented in the hospital, not applicable
		Temperature air reduction from green indoors (i.e.: walls, corridors and facades) (*)	°C	6 month	Air temperature sensors and relative humidity sensors - Automatic	Engineering Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	No green indoors systems will be implemented in the hospital, not applicable
		Temperature of external air reduction from tree planting (*)	°C	6 month	Air temperature sensors and relative humidity sensors -	Engineering Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	Applicable for the measures planned to be installed. Not measurable with the already installed weather station which are used to monitor weather in Nikaia for another European project. Misurable with outside temperature monitoring system with frequency not constant, but better to measure

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
					Automatic			when it's needed. To keep in consideration that the hospital does not plan to plant so many trees that will influence the temperature
	Climate co-benefits	Carbon sequestration from tree planting	kg CO_2	6 month/ yearly	\	Engineering Department	Carbon storage and sequestration by urban trees in the USA: *https://www.sciencedirect.com/science/article/abs/pii/S0269749101002147* How to calculate the amount of CO2 sequestered in a tree per year:*http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf*	Calculated by RINA, based on the number of trees planted. The calculation is performed by considering an average net carbon sequestration annual value for a tree, and associated carbon dioxide amount. Then, the factor obtained is multiplied by the minimum number of trees expected to be planted in each pilot
		Reduction of heat island effect through green infrastructure (*)	°C	6 month/ yearly	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer - Automatic	Engineering Department	The Impact of Green Areas on Mitigating Urban Heat Island Effect: *https://www.researchgate.net/publication/271206461* Temp. reduction in a treed urban environment can reach up to 4° C and it depends on the size of the park, amount of trees and grass cover in the park and choice of species. Street trees could influence air temp. significantly	Possible merge with n.11 and n.13 rows
		Air pollution removal (PM_{10} and O_3) (*)	kg	6 month/ yearly	Monitoring stations - Automatic	Engineering department/ Regional autorities	Air pollution removal factors for deciduous broadleaved trees: O_3 0.0310 t/ha/y; PM_{10} 0.0176 t/ha/y *https://www.sciencedirect.com/science/article/pii/S2210784316300997* Assuming 1 year effects of green outdoor measures during the project, based on the project timeline	Can be calculated by RINA, based on the number of green outdoor measures.
Better use of resources	Energy	Reduced energy consumption	%	monthly	Energy bills, meter - Manual	Engineering Department	Large Hospital 50% Energy Savings - Technical Support Document: *https://www.nrel.gov/docs/fy10osti/47867.pdf*	Nikaia is an example of "urban" hospital and has a big budget for grey measures, for which the hospital plan to substitute the big chillers (30 years old) that feeds with cold water for air conditioning/cooling the 5th floor building.

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
								Other European project measure thermal comfort in the room: for this the hospital already installed 94 sensors in 20 indicative rooms; they plan to replace the new windows in summer, then they will monitor the thermal comfort one year later.
		Energy produced from Renewable (**)	kwh	yearly	Energy bills, meter	Engineering Department	The indicator also includes purchase of electricity from supplier that produces energy from renewable sources or not.	Solar/photovoltaic panels are currently not present in the hospital but could be implemented. Also includes purchase of electricity from supplier that produces energy from renewable sources or not.
		Monitoring of the energy savings due to the improvement of the existing air conditioning systems	kwh	monthly	Energy bills, meter	Engineering Department	Large Hospital 50% Energy Savings - Technical Support Document: *https://www.nrel.gov/docs/fy10osti/47867.pdf*	Applicable and measurable
	Food	Meal with locally and sustainably food on total meal served (**)	%	yearly	\	Catering company	*https://climatecouncil.noharm.org/*	\
	Waste	Waste reduction program (e.g: reuse bags, organics recycling, training, compost food waste etc.) and consequent financial saving (**)	N. Euros	yearly	\	Engineering Department	According to *'https://climatecouncil.noharm.org/* waste management represents 1-5% of U.S. GHG emissions and hospitals produce an average of 30 pounds of waste per patient/day	The hospital has no such a program at the moment
		Quantity of waste reduction during the project according to waste reduction program, detailed for waste cathegory (hazardous, non hazardous) (**)	tons	yearly	\	Engineering Department	\	\
Social, Political and Economic Performance, Market Uptake, Replication	Employment	New jobs created (full time employee) in the project	N.	6 months	HR Registers	HR Dep.	Based on the staff ("Additional staff" to be hired in the project (see proposal – F Part – F1)	\
	New infrastructure	Investments in blue-green and grey infrastructures	euros	6 months	Business plan	Technical dep. Financial resource dep.	Calculation of the investments in Infrastructures costs (see proposal – F Part – F4a F4b)	\
	Project Results' Replication / Transfer	Hospital/health system using Upscaling Adaptation Starting Package (UASP) in the country	N.	end of project	\	Financial resource dep. Administrative Dep.	Replication/transfer of project results secured through the work of " *Scaling Network and Facilitation Board*", will be monitored, thanks to RINA-C's	\

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
							involvement in Action C5.3 (M37-M48). Hp: one hospital/health system already using "Upscaling Adaptation Starting Package (UASP)" - *provided in open source on the project website* - at the end of the project (one in the country of each pilot).	
	Guidance and tools	Training/capacity building activities about: *system-approach developed, capacity building programmes designed, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at integrating health and climate policy*	N.	3 months	Attendance registers (training)	Communication De./ Information office	At the end of the project the number of guidance and tools is expected to be > 3	Training of medical staff and patients. Dissemination also through leafleting (in notice boards introduction in common hospital spaces) Possible merge with rows n. 29 and n. 30
Communication, dissemination, awareness rising	Awareness raising	Stakeholders engaged	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: CoPs=105 members Facilitation Board=20 members Scaling network=30 members WHO, WGIN and others = 10 people	To be planned within project partners To be defined: what to share with stakeholders about the project and the engagement method
		Entities/individuals reached/ made aware	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: 210 hospitals, 10 investors 175 managers and authorities 10 National/EU policy makers 10 insurance companies 50 building/civil engineering companies 50 experts of blue-green infrastructures, renaturation, CC and biodiversity 7000 general public (1000 people/hospital)	To be planned within project partners
		People trained to modules 1 to 6 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 15 people per pilot hospital	\

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		People trained to module 7 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 10 people per pilot hospital	\
		Articles produced in itinere on the project	N.	3 months	Excel file	Communication De./ Information office	See proposal – Part B – B4	\
		Workshops and events organized	N.	3 months	Excel file	Communication De./ Information office	1 workshop per hospital 1 workshop organised by UCAM 2 workshop organised by HCWHE 5 webinars of Scaling Network 3 webinars of Facilitation Board 1 Optimisation workshop/pilots	To be planned within project partners
	Website	Visitors per month (**)	N.	monthly	Webinar click software	IT Department	Based on usual numbers, average number reached starting from M12 (after some engagement activities)	\
	Stakeholders Behavioural change	Entities/individuals changing behaviour as a result of their engagement in the project	N.	3 months	webinar, interview, survey	Communication De./ Information office	Assumption: 80% of stakeholders engaged	To be defined the type of behaviour to be investigated

3.3 Hospital Center of Millau

Please note that:

- indicators marked with (**) could potentially be monitored right away – at the start of the project;
- indicators marked with (*) would require the purchase of appropriate equipment as the one described in DD1.2 "*Physical Monitoring Design*", which is not already installed in the pilot hospitals (as per interviews with the various hospitals).

Table 10: List of KPIs for Hospital Center of Millau

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
Improved Environmental and Climate Performance (including resilience to climate change)	Green and Blue infrastructure	Hectars of green (i.e. tree planting, rewilding of lawns, green roof, absorbent parks) and blue (i.e. rivers, canals, ponds, wetlands, floodplains, water treatment facilities, sustainable urban drainage systems) infrastructures created (*)	m2/ha	6 month/ yearly	Laser distance meter of green area covered - Manual	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks N. 10 trees correspond to 100 m2 of green infrastructures	The hospital plan to implement only green (not blue) measures. Considering 4 year project, investigate if also existing infrastructure have to be kept in consideration
	Climate hazards - Infrastructure resilience	Total hospitalized patients in buildings at risks (*see Table 0.2 Hospitals' data and information*) (**)	N.	yearly	Medical electronic record - Manual	-Hospital personnel -IT Dep. -Administrative Dep.	Needed for the percentage below	The number is almost constant:400 total hospitalize patients and 700 beds maximum (if more people come to the emergency room, they are moved to other hospitals)
		Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients	%	yearly	Survey - Manual	-Hospital personnel -Stakeholders to facilitate communication with patients -IT Dep.	Impact in % estimated compared to the whole number of yearly hospitalized patients.	To be investigated: in which way to propose/distribute the questionnaire. It would be useful to organise a meeting with the "patients committee" group.
		Buildings with improved resilience thanks to Green and Blue infrastructure (*see Table 0.2 Hospitals' data and information)*	N. or %	6 month/ yearly	\	Technical Department	Impact in % estimated compared to the whole number of buildings at risks	Only green infrastructures are planned to be implemented
	Climate hazards - Flooding	Hectars (improved conditions) (*)	ha	6 month	Laser distance meter of green area covered - Manual	Technical Department	Assuming that tree planting, rewilding and green corridors infrastructures contribute to improved flooding resilience	Possible merge with similar indicators

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		Runoff reduction thanks to Green and Blue (*)	%	6 month/ yearly	Water flow sensors or balancing tanks – Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	\
	Air - Improved resilience to heat waves	Temperature air reduction from green roofs and facades outdoor (*)	°C	6 month	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer - Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	If it will be monitored more frequently, it shall be equipped with automatic temperature recording devices capable of recording the temperature at least once every 24 hours.
		Temperature air reduction from green indoors (i.e.: walls, corridors and facades) (*)	°C	6 month	Air temperature sensors and relative humidity sensors Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	If it will be monitored more frequently, it shall be equipped with automatic temperature recording devices capable of recording the temperature at least once every 24 hours.
		Temperature of external air reduction from tree planting (*)	°C	6 month	Air temperature sensors and relative humidity sensors Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	If it will be monitored more frequently, it shall be equipped with automatic temperature recording devices capable of recording the temperature at least once every 24 hours.
	Climate co-benefits	Carbon sequestration from tree planting	kg CO_2	6 month/ yearly	\	Technical Department	Carbon storage and sequestration by urban trees in the USA: *https://www.sciencedirect.com/science/article/abs/pii/S0269749101002147* How to calculate the amount of CO2 sequestered in a tree per year:*http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf*	Calculated by RINA, based on the number of trees planted. The calculation is performed by considering an average net carbon sequestration annual value for a tree, and associated carbon dioxide amount. Then, the factor obtained is multiplied by the minimum number of trees expected to be planted in each pilot

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		Reduction of heat island effect through green infrastructure (*)	°C	6 month/ yearly	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer - Automatic	Technical Department	The Impact of Green Areas on Mitigating Urban Heat Island Effect: https://www.researchgate.net/publication/271206461 Temp. reduction in a treed urban environment can reach up to 4° C and it depends on the size of the park, amount of trees and grass cover in the park and choice of species. Street trees could influence air temp. significantly	To be measured during summer
		Air pollution removal (PM_{10} and O_3) (*)	kg	6 month/ yearly	Monitoring stations - Automatic	Engineering department/ Regional autorities	Air pollution removal factors for deciduous broadleaved trees: O_3 0.0310 t/ha/y; PM_{10} 0.0176 t/ha/y https://www.sciencedirect.com/science/article/pii/S2210784316300997 Assuming 1 year effects of green outdoor measures during the project, based on the project timeline	Shall be equipped with automatic pollution recording devices.
Better use of resources	Energy	Reduced energy consumption	%	monthly	Energy bills, meter - Manual	Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: https://www.nrel.gov/docs/fy10osti/47867.pdf	\
		Energy produced from Renewable (**)	kwh	yearly	Energy bills, meter	Technical Department	The indicator also includes purchase of electricity from supplier that produces energy from renewable sources or not.	\
		Monitoring of the energy savings due to the improvement of the existing air conditioning systems	kwh	monthly	Energy bills, meter	Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: https://www.nrel.gov/docs/fy10osti/47867.pdf	\
	Food	Meal with locally and sustainably food on total meal served (**)	%	yearly	\	Catering company	https://climatecouncil.noharm.org/	\

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
	Waste	Waste reduction program (e.g: reuse bags, organics recycling, training, compost food waste etc.) and consequent financial saving (**)	N. Euros	yearly	\	Technical Department	According to *'https://climatecouncil.noharm.org/* waste management represents 1-5% of U.S. GHG emissions and hospitals produce an average of 30 pounds of waste per patient/day	To be evaluated a change in Unit of Measure: euro could not be relevant - because not representative - so financial impact shall be identified by type of waste and treatment Moreover, it should evaluate in % of evolution compared to an initial state.
		Quantity of waste reduction during the project according to waste reduction program, detailed for waste cathegory (hazardous, non hazardous) (**)	tons	yearly	\	Technical Department	\	\
Social, Political and Economic Performance, Market Uptake, Replication	Employment	New jobs created (full time employee) in the project	N.	6 months	HR Registers	HR Dep.	Based on the staff ("Additional staff" to be hired in the project (see proposal – F Part – F1)	\
	New infrastructure	Investments in blue-green and grey infrastructures	euros	6 months	Business plan	Technical dep. Financial resource dep.	Calculation of the investments in Infrastructures costs (see proposal – F Part – F4a F4b)	\
	Project Results' Replication / Transfer	Hospital/health system using Upscaling Adaptation Starting Package (UASP) in the country	N.	end of project	\	Financial resource dep. Administrative Dep.	Replication/transfer of project results secured through the work of " *Scaling Network and Facilitation Board*", will be monitored, thanks to RINA-C's involvement in Action C5.3 (M37-M48). Hp: one hospital/health system already using "Upscaling Adaptation Starting Package (UASP)" - *provided in open source on the project website* - at the end of the project (one in the country of each pilot).	\
	Guidance and tools	Training/capacity building activities about: *system-approach developed, capacity building programmes designed, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at*	N.	3 months	Attendance registers (training)	Communication De./ Information office	At the end of the project the number of guidance and tools is expected to be > 3	\

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		integrating health and climate policy						
Communication, dissemination, awareness rising	Awareness raising	Stakeholders engaged	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: CoPs=105 members Facilitation Board=20 members Scaling network=30 members WHO, WGIN and others = 10 people	To be planned within project partners
		Entities/individuals reached/ made aware	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: 210 hospitals, 10 investors 175 managers and authorities 10 National/EU policy makers 10 insurance companies 50 building/civil engineering companies 50 experts of blue-green infrastructures, renaturation, CC and biodiversity 7000 general public (1000 people/hospital)	To be planned within project partners
		People trained to modules 1 to 6 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 15 people per pilot hospital	\
		People trained to module 7 of A3.1 (page 49 proposal)	N.	3 months	Attendance registers	Communication De./ Information office	At least 10 people per pilot hospital	\
		Articles produced in itinere on the project	N.	3 months	Excel file	Communication De./ Information office	See proposal – Part B – B4	\
		Workshops and events organized	N.	3 months	Excel file	Communication De./ Information office	1 workshop per hospital 1 workshop organised by UCAM 2 workshop organised by HCWHE 5 webinars of Scaling Network 3 webinars of Facilitation Board 1 Optimisation workshop/pilots	To be planned within project partners

Objectives	Indicators		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
	Website	Visitors per month (**)	N.	monthly	Webinar click software	IT Department	Based on usual numbers, average number reached starting from M12 (after some engagement activities)	Indicator considered not so relevant for the project. It is suggested a post on social networks (LinkedIn or Facebook).
	Stakeholders Behavioural change	Entities/individuals changing behaviour as a result of their engagement in the project	N.	3 months	webinar, interview, survey	Communication De./ Information office	Assumption: 80% of stakeholders engaged	The assumption on answers looks optimist; for France 20% is more realistic. To be defined the parameter to collect info/change of feeling during the project (in different meetings for example the periodic 6 monthly of the CoP)

3.4 Galician Health Service

Please note that:

- indicators marked with (**) could potentially be monitored right away – at the start of the project;
- indicators marked with (*) would require the purchase of appropriate equipment as the one described in DD1.2 "*Physical Monitoring Design*", which is not already installed in the pilot hospitals (as per interviews with the various hospitals).

Table 11: List of KPIs for Galician Health Service

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
Improved Environmental and Climate Performance (including resilience to climate change)	Green and Blue infrastructure	Hectars of green (i.e. *tree planting*, rewilding of lawns, *green roof/walls*, absorbent parks) and blue (i.e. rivers, canals, ponds, wetlands, floodplains, *water treatment facilities, sustainable urban drainage systems*) infrastructures created (*)	m2/ha	6 month /yearly	Laser distance meter of green area covered - Manual	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks N. 10 trees correspond to 100 m2 of green infrastructures	Considering 4 year project, investigate if also existing infrastructure have to be kept in consideration The three hospitals plan to install both green and blue (rainwater collection and utilization system) measures
	Climate hazards - Infrastructure resilience	Total hospitalized patients in buildings at risks (*see Table 0.2 Hospitals' data and information*) (**)	N.	yearly	Medical electronic record - Manual	-Hospital personnel -IT Dep. -Administrative Dep.	Needed for the percentage below	Needed for the percentage below
		Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients	%	yearly	Survey - Manual	-Hospital personnel -Stakeholders to facilitate communication with patients -IT Dep.	Impact in % estimated compared to the whole number of yearly hospitalized patients.	The distribution method preferred is through IT channel (SMS) as already did for some initiatives, other than physical survey. Green corridors to be evaluated if to expand also to professional (staff of the hospital) other than indoor patients, keeping in consideration the right numerator of the ratio.
		Buildings with improved resilience thanks to Green and Blue infrastructure (*see Table 0.2 Hospitals' data and information)*	N. or %	6 month/ yearly	\	Technical Department	Impact in % estimated compared to the whole number of buildings at risks	Possible merge with other indicators
	Climate hazards - Flooding	Hectars (improved conditions) (*)	m2/ ha	6 month	Laser distance meter of green area	Technical Department	Assuming that tree planting, rewilding and green corridors	Possible merge with other indicators. It should keep in consideration the area where the hospital is located. The indicator will be more

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
					covered - Manual		infrastructures contribute to improved flooding resilience	significative for rural area (Verin hospital) than urban/city area.
		Runoff reduction thanks to Green and Blue (*)	%	6 month/ yearly	Water flow sensors or balancing tanks – Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	Important to be in the same season to measure
	Air - Improved resilience to heat waves	Temperature air reduction from green roofs and facades outdoor (*)	°C	6 month	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer- Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	The roofs of the hospitals are already full with photovoltaic panels and equipments.
		Temperature air reduction from green indoors (i.e.: walls, corridors and facades) (*)	°C	6 month	Air temperature sensors and relative humidity sensors Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	\
		Temperature of external air reduction from tree planting (*)	°C	6 month	Air temperature sensors and relative humidity sensors Automatic	Technical Department	RESIN H2020 - Library. Database of adaptation measures addressing climate risks	It should keep in consideration the area where the hospital is located. The indicator will be more significative for rural area (Verin hospital) than urban/city area.
	Climate co-benefits	Carbon sequestration from tree planting	kg CO_2	6 month/ yearly	\	Technical Department	Carbon storage and sequestration by urban trees in the USA: *https://www.sciencedirect.com/science/article/abs/pii/S0269749101002147* How to calculate the amount of CO2 sequestered in a tree per year:*http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf*	Calculated by RINA, based on the number of trees planted. The calculation is performed by considering an average net carbon sequestration annual value for a tree, and associated carbon dioxide amount. Then, the factor obtained is multiplied by the minimum number of trees expected to be planted in each pilot

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		Reduction of heat island effect through green infrastructure (*)	°C	6 month/ yearly	Sensors for air temperature and relative humidity, thermoresistors, pyranometer, anemometer- Automatic	Technical Department	The Impact of Green Areas on Mitigating Urban Heat Island Effect: *https://www.researchgate.net/publication/271206461* Temp. reduction in a treed urban environment can reach up to 4° C and it depends on the size of the park, amount of trees and grass cover in the park and choice of species. Street trees could influence air temp. significantly	Possible merge with n.11 row
		Air pollution removal (PM_{10} and O_3) (*)	kg	6 month/ yearly	Monitoring stations - Automatic	Technical Department / Regional autorities	Air pollution removal factors for deciduous broadleaved trees: O_3 0.0310 t/ha/y; PM_{10} 0.0176 t/ha/y *https://www.sciencedirect.com/science/article/pii/S2210784316300997* Assuming 1 year effects of green outdoor measures during the project, based on the project timeline	\
Better use of resources	Energy	Reduced energy consumption	%	monthly	Energy bills, meter - Manual	Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: *https://www.nrel.gov/docs/fy10osti/47867.pdf*	To be inserted examples of interventions (e.g.: grey equipment substitutions) which bring to energy consumption reduction
		Energy produced from Renewable (**)	kwh	yearly	Energy bills, meter	Technical Department	The indicator also includes purchase of electricity from supplier that produces energy from renewable sources or not.	The hospitals are already equipped with photovoltaic panels, biomass plant and micro-cogeneration system
		Monitoring of the energy savings due to the improvement of the existing air conditioning systems	kwh	monthly	Energy bills, meter	Technical Department	Large Hospital 50% Energy Savings - Technical Support Document: *https://www.nrel.gov/docs/fy10osti/47867.pdf*	Applicable to Verin hospital for a new equipment for air condition. Other than that, no more intervention but a possible change in parameters of the current equipment. It should be detail some examples for "improvement".
	Food	Meal with locally and sustainably food on total meal served (**)	%	yearly	\	Catering company	*https://climatecouncil.noharm.org/*	Detail connection with food transportation emissions Better define what "locally" and "sustainable" means, or investigate with already screened catering companies. Ourense and Valdeocrras hospitals has an internal management while in Verin hospital the provider is an

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
								external company, screened with social responsibility strategy criteria.
	Waste	Waste reduction program (e.g: reuse bags, organics recycling, training, compost food waste etc.) and consequent financial saving (**)	N. Euros	yearly	\	Technical Department	According to *'https://climatecouncil.noharm.org/* waste management represents 1-5% of U.S. GHG emissions and hospitals produce an average of 30 pounds of waste per patient/day	To be detail what financial saving means. Possible organic waste from the kitchen with collaboration with local universities In the hospital strategy are already involved aspects such as management of plastic and there is a collaboration "Health Care Without Harm Europe AISBL" (project's partner) for the management the waste produced.
		Quantity of waste reduction during the project according to waste reduction program, detailed for waste cathegory (hazardous, non hazardous) (**)	tons	yearly	\	Technical Department	\	\
Social, Political and Economic Performance, Market Uptake, Replication	Employment	New jobs created (full time employee) in the project	N.	6 months	HR Registers	HR Dep.	Based on the staff ("Additional staff" to be hired in the project (see proposal – F Part – F1)	To be investigated if is better to indicate the new jobs created in general term over the 4 years or the people hired for RESYSTAL project (e.g. maintenance of green areas) Possible substitution with turnover rate.
	New infrastructure	Investments in blue-green and grey infrastructures	euros	6 months	Business plan	Technical dep. Financial resource dep.	Calculation of the investments in Infrastructures costs (see proposal – F Part – F4a F4b)	\
	Replication / Transfer	Hospital/health system using Upscaling Adaptation Starting Package (UASP) in the country	N.	end of project	\	Financial resource dep. Administrative Dep.	Replication/transfer of project results secured through the work of " *Scaling Network and Facilitation Board*", will be monitored, thanks to RINA-C's involvement in Action C5.3 (M37-M48). Hp: one hospital/health system already using "Upscaling Adaptation Starting Package (UASP)" - *provided in open source on the project website* - at the end of the project (one in the country of each pilot).	\
	Guidance and tools	Training/capacity building activities about: *system-approach developed, capacity building*	N.	yearly	Attendance registers (training)	Communication De./ Information office	At the end of the project the number of guidance and tools is expected to be > 3	Frequency yearly because the training activities are usually planed with a yearly base.

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
		programmes designed, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at integrating health and climate policy						
Communication, dissemination, awareness rising	Awareness raising	Stakeholders engaged	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: CoPs=105 members Facilitation Board=20 members Scaling network=30 members WHO, WGIN and others = 10 people	\
		Entities/individuals reached/ made aware	N.	6 months	webinar, interview	Communication De./ Information office	See proposal – Part B – B4: 210 hospitals, 10 investors 175 managers and authorities 10 National/EU policy makers 10 insurance companies 50 building/civil engineering companies 50 experts of blue-green infrastructures, renaturation, CC and biodiversity 7000 general public (1000 people/hospital)	\
		People trained to modules 1 to 6 of A3.1 (page 49 proposal)	N.	yearly	Attendance registers	Communication De./ Information office	At least 15 people per pilot hospital	To be detail which hospital department is better to involve, considering the specific technical topics of this training. Yearly frequency because usually training activities are plan yearly in this hospital
		People trained to module 7 of A3.1 (page 49 proposal)	N.	yearly	Attendance registers		At least 10 people per pilot hospital	
		Articles produced in itinere on the project	N.	3 months	Excel file		See proposal – Part B – B4	\
		Workshops and events organized	N.	3 months	Excel file	Communication De./ Information office	1 workshop per hospital 1 workshop organised by UCAM 2 workshop organised by HCWHE 5 webinars of Scaling Network 3 webinars of Facilitation Board 1 Optimisation workshop/pilots	To be planned within project partners
	Website	Visitors per month (**)	N.	monthly	Webinar click software	IT Department	Based on usual numbers, average number reached	The sharing is better with social network platform (Facebook, Twitter). Since the hospitals has no current website (planned to future).

Objectives	Indicators (KPIs)		U.M.	Monitoring			Data Source and RINA Hypothesis	Hospital Comment
				Freq.	Devices	Actors involved		
							starting from M12 (after some engagement activities)	
	Behavioural change	Entities/individuals changing behaviour as a result of their engagement in the project	N.	3 months	webinar, interview, survey	Communication De./ Information office	Assumption: 80% of stakeholders engaged	To be detail what kind of behavior with examples

4. Conclusions

This initial analysis provides a preliminary common monitoring methodology to allow proper evaluation of the project actions and their expected results along the project duration and beyond.

As shown in the tables above, some of the performance indicators proposed by RINA have been commonly evaluated by the referents of the pilot hospitals as not particularly useful for monitoring hospital adaptation to climate change, for example the indicator related to "*Patients health (status benefit) since the introduction of green infrastructures compared to the total number of hospitalized patients*".

Moreover, some suggestions have been made to merge some indicators with others, such as:

- *Buildings with improved resilience thanks to Green and Blue infrastructure (see Table 0.2 Hospitals' data and information);*
- *Hectars (improved conditions);*
- *Reduction of heat island effect through green infrastructure;*
- *Training/capacity building activities about: system-approach developed, capacity building programmes designed, avoided economic losses, investments in climate adaptation, description and number of EU policy initiatives aimed at integrating health and climate policy*.

Finally, for some indicators it was suggested to detail with usual cases of examples, such as:

- List of possible improvement measures mentioned in the indicator "*Monitoring of the energy savings due to the improvement of the existing air conditioning systems";*
- Definition of "local and sustainable food" described in the indicator "*Meal with locally and sustainably food on total meal served";*
- Examples of behaviour specified in the indicator "*Entities/individuals changing behaviour as a result of their engagement in the project".*

The modifications/replacement of some indicators will be evaluated over the course of the project depending on the above considerations and the project developments.

In fact, the proposed KPIs list within this deliverable (3. Common Monitoring Methodology chapter) consist in a preliminary foundation for further consideration along the all project life (to 2025) and the list will be finally updated in Action D.4 named "Following of the LIFE key project indicators". In particular, as indicated in DA1.4 "*Monitoring committees set up in each pilot*" led by ACTERRA, a near-final or more accurate list of the KPIs proposed here will be approved by each hospital's monitoring committee during 2nd plenary meeting of CoPs (around June 2022).