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iDEAL - DEcision support for Adaptation pLan

Priority Axis: Safety and resilience

Specific objective: 2.1 - Improve the climate change monitoring and planning of adaptation measures tackling specific effects, in the cooperation area

WP3 DEFINITION AND MONITORING OF CLIMATE ADAPTATION PLANS Activity 3.3 MONITORING SYSTEM

3.3.1 Database of indicators 3.3.2 Monitoring system

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LP - IRENA – Istrian Regional Energy Agency

PP1 - MUNICIPALITY OF PESARO

PP3 - MUNICIPALITY OF MISANO ADRIATICO

PP4 - CITY OF DUBROVNIK DEVELOPMENT AGENCY DURA

PP5 - REGIONAL NATURAL PARK “COASTAL DUNES FROM TORRE
CANNE TO TORRE SAN LEONARDO”

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1. Introduction

Based on the knowledge provided by climate vulnerability, risk analysis and policies already implemented, Climate Adaptation Plans have been developed for all iDEAL partner, cities or countries. These are going to be adopted by municipalities or counties, thanks to the use of a DSS developed to support decisions regarding climate adaptation measures. Built on these studies, the knowledge and skills acquired by policymakers will have a long lifespan, until they become obsolete, as they will be used in the daily activities of interested policymakers, while the number of inhabitants enjoying climate adaptation planning should increase as a result of a more widespread and refined use of the processed DSS. The progression in implementing the plan has depended heavily on each partner, on the available data, knowledge, and information, but the process that leads to the adoption of adaptation plans is transferable to any other social context facing adaptation to climate changes. The structure defined for the preparation of the climate adaptation plan is the following:



Image 1. Climate Adaptation Plan steps

2. Indicators database

In order to have a contextual and coherent monitoring system with the (5) areas under study, each partner was asked to choose a set of indicators related to the previously selected impacts. Based on these sets of indicators, the effectiveness of each action will be evaluated to facilitate an understanding of the obtained results.

This phase took place thanks to the compilation of a generic format for all PPs, where each PP has chosen its quantitative indicators. The PPs presented lists of indicators, designed according to their specific socioeconomic context.

2.1 Database of indicators to assess the CC impacts

1. Surface of green areas: *It is the amount of new green areas provided by the action*
2. Surface of built-up areas: *It is the amount of new built-up areas made by the action.*
3. Land surface temperature mean value.
4. NDVI: *Normalized Difference Vegetation Index*
5. NDBI; *Normal Difference Built-up Index*
6. Surface of areas no longer vulnerable to “sea level rise” by scenario involving 1 m sea-level rise
7. Impermeable surface: *It is the amount of new built-up areas made by the action*
8. Floristic areas: *It is the amount of Floristic areas provide by the action*
9. Public beaches surface: *It is the number of Public beaches provide by the action*
10. Dunes surface: *It is the number of dunes provide by the action*
11. Coastal protection infrastructures: *It is the amount of GI provide by the action*
12. Water consumption: *It is the amount of fresh water saved by the action,*

2.2 Chosen set of indicators and related impact

IRENA (Vrsar, Rovinj, Poreč)

Urban heat island, variables considered:

- Surface of green areas: It is the amount of new green areas provided by the action.
- Surface of built-up areas: It is the amount of new built-up areas made by the action.
- Land surface temperature mean value.

Urban flooding, variables considered:

- NDVI: Normalized Difference Vegetation Index
- NDBI; Normal Difference Built-up Index

Sea level rise, variables considered:

- Surface of areas no longer vulnerable to “sea level rise” by scenario involving 1 m sea-level rise

Municipality of Dubrovnik

Urban heat island, variables considered:

- Surface of green areas: It is the amount of new green areas provided by the action.
- Surface of built-up areas: It is the amount of new built-up areas made by the action.
- Land surface temperature mean value.

Urban flooding, variables considered:

- NDVI: Normalized Difference Vegetation Index
- NDBI; Normal Difference Built-up Index

Sea level rise, variables considered:

- Surface of areas no longer vulnerable to “sea level rise” by scenario involving 1 m sea-level rise

Dune Costiere Park

Coastal erosion, variables considered:

- Surface of green areas: It is the amount of new green areas provided by the action.
- Surface of built-up areas: It is the amount of new built-up areas made by the action.

Municipality of Pesaro

Increased energy demand for cooling, variables considered:

- Surface of green areas: It is the amount of new green areas provided by the action.
- Impermeable surface: It is the amount of new built-up areas made by the action
- Land surface temperature mean value

Increased coastal erosion in natural areas, variables considered:

- Floristic areas: It is the amount of Floristic areas provide by the action
- Public beaches surface: It is the number of Public beaches provide by the action
- Dunes surface: It is the number of dunes provide by the action
- Coastal protection infrastructures: It is the amount of GI provide by the action

Water competition, variables considered:

- Water consumption: It is the amount of fresh water saved by the action, based on MarcheMultiservizi data.

Municipality of Misano

Increased energy demand for cooling, variables considered:

- Surface of green areas: It is the amount of new green areas provided by the action.
- Impermeable surface: It is the amount of new built-up areas made by the action
- Land surface temperature mean value

3. Monitoring system

The monitoring of climate adaptation plans carried out in activity 3.3, is an important step to raise awareness and improve knowledge about climate change impacts in local context. The kind of information obtained through these analyzes is a fundamental component to control and monitoring climate adaptation plans, as well as to support local public administrations to make appropriate decisions related to climate measures and to develop coherent actions.

Sector	Impacts
Agriculture	Variation in crop yield
	Variation in livestock production
	Increased irrigation demand
Hydrology and water resources	Increase of drought
	Increase of flooding
	Increased competition for water
	Increase of urban flooding
Coasts	Increased erosion
	Coastal flooding
	Damage to costal human infrastructures
	Damage to costal natural environments
Energy	Impacts on energy infrastructures (energy plants, etc)
	Increased energy demand for cooling
Socio-economic	Increased Urban Heat Island effect
	Impacts on weakest group of people
	Impacts on commercial activities
	Impacts on public services
	Impacts on industrial activities
	Impacts on transportation network
	Impacts on tourism sector
Ecosystems and environment	Loss of species
	Loss of habitat
	Increased forest fires
	Increase of invasive species and parasites

Table 1: First list of climate change impacts from which the PPs are asked to choose

The methodology was undertaken to develop a specific "monitoring system" based on the algorithms used in the first part of analyzes about the selected impacts, from a first list (Table 1). This is particularly useful as it allows a rational comparison between the initial and project status for each pilot area. Therefore, for each area there are specific indicators that refer to the initial set of selected impacts, to evaluate the ability to adapt to the current urban territory.

3.1 Definition of data & process factor

To develop an appropriate analysis for each case study, as mentioned above it was decided, in agreement with all partners to focus on four main climate change impacts (and related hazards) identified as the most relevant for the pilot areas. The monitoring system is generally necessary as it can assess the degree of efficiency of a measure or action, in complying with some of the needs present in the context. In this case, it was decided to evaluate, how these initiatives can adapt to the local landscape concerning the set of impacts chosen by each case.

Furthermore, for each PP, the system was contextualized, firstly based on the available data and information, and subsequently based on the actions proposed and related impact within the Climate Adaptation Plan. To ensure certain ease in its use, the graphic interface has been the subject of numerous graphic and functional revisions. We have chosen to simplify the visualization of data and functions as much as possible in order to limit the possible discomfort deriving from matrices with more than 17 mathematical operators. The result of this operation consists of a summary table, containing starting and monitoring data, which allow a simple and immediate reading of the system, as shown in Table3.

Pilot area	Impacts
Misano Adriatico	Increased coastal erosion
	Increased energy demand for cooling
	Impacts on transportation network
	Impacts on tourism sector
Pesaro	Increased competition for water
	Increased coastal erosion in natural areas
	Increased energy demand for cooling
	Impacts on tourism sector
Parco delle Dune Costiere	Variation in crop yield

	Increase of drought
	Increased coastal erosion
	Loss of habitat
Dubrovnik & Rovinj, Vrsar, Poreč	Urban heat Island
	Urban flooding
	Sea level rise

Table 2 - Ultimate list of impacts for each pilot area

The algorithms are composed of mathematical factors, variables and constants that depending on the activities carried out can change the impact coefficient: evaluating the effects on the territory under study. Next, the list including the various factors considered in the elaboration of risks and impacts:

- *DSM (Digital Surface Model)*
- *DTM (Digital Terrain Model)*
- *Land Cover*
- *Land Use*
- *Protected Areas, ZPS, SIC*
- *Soil Type and geological map*
- *Administrative unit boundaries*
- *Population census data*
- *Buildings and infrastructures (street and railway, etc.)*
- *Slow mobility network*
- *Hydrology map*
- *Beach Nourishment Plan*
- *Cadastral data (commercial tourism activities, residential etc.)*
- *Cultural and Natural Heritage*
- *Tourist numbers data*
- *Tourist infrastructures and buildings*
- *Water consumption by sector (as detailed as possible)*
- *Energy Performance Certificate for Building*
- *Agriculture typology map*
- *Daily Precipitation and temperature data 1990 – 2017*

The system is therefore based on multiple factors, but the monitoring system proposed here is limited to considering only the factors that change about the action taken.

ACTION n° 2 TITLE: WAVES TO ENERGY						
RELATED IMPACT THAT THE ACTION MITIGATES					URBAN HEAT ISLAND	
ID Hexagon	LST_mean	Veg_mq	Buid_mq		Index UHI- starting point	Index UHI- monitoring point
					#N/D	#N/D

RELATED IMPACT THAT THE ACTION MITIGATES					URBAN FLOODING	
ID Hexagon	NDVI	NDBI			Index UHI- starting point	Index UHI- monitoring point
0					#N/D	0

RELATED IMPACT THAT THE ACTION MITIGATES					SEA LEVEL RISE	
ID Hexagon	Mq < 1m above sea-level				Index UHI- starting point	Index UHI- monitoring point
0					#N/D	#N/D

Table 3 - Ultimate selected graphic interface

IRENA (Vrsar, Rovinj, Poreč)

WP3 - MONITORING implementation - PP IRENA

ACTION n° 1 TITLE: WATER HEAT PUMPS - THE ORTHOPEDIC AND REHABILITATION HOSPITAL "PRIM.DR.MARTIN HORVAT"

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 2 TITLE: WAVES TO ENERGY

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 3 TITLE: OVERTOPPING BREAKWATER

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 4 TITLE: SEA KITE

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 5 TITLE: DEEP GREEN

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 6 TITLE: NATURAL SHADING AND PLANTING

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN HEAT ISLAND	
0-Mitigation	1-1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 7 TITLE: PROTECTION OF COASTAL INFRASTRUCTURE - ROVINJ

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				URBAN FLOODING	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

RELATED IMPACT THAT THE ACTION MITIGATES:				SEA LEVEL RISE	
0-Mitigation	1st phase	2nd phase	3rd phase	Index 100 (mitigation point)	Index 100 (mitigation point)
				0.000	0.000

ACTION n° 8 TITLE: PROTECTION OF COASTAL INFRASTRUCTURE - VSAR			
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN FLOODING	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
RELATED IMPACT THAT THE ACTION MITIGATES		SEA LEVEL RISE	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ACTION n° 9 TITLE: PROTECTION OF COASTAL INFRASTRUCTURE - POREC'			
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN FLOODING	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
RELATED IMPACT THAT THE ACTION MITIGATES		SEA LEVEL RISE	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	

Municipality of Dubrovnik

WP4 - MONITORING SYSTEM - PP DURA			
ACTION n° 1 TITLE: PARKING LOTS ALTERATION -			
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN HEAT ISLAND	
ID Measure	U1T_innov	U1g_innov	U1k_innov
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN FLOODING	
ID Measure	NDA	NDB	
ACTION n° 2 TITLE: SEA WALL			
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN FLOODING	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
RELATED IMPACT THAT THE ACTION MITIGATES		SEA LEVEL RISE	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ID Measure	NDA	NDB	
ACTION n° 3 TITLE: GREEN ROOF			
RELATED IMPACT THAT THE ACTION MITIGATES		URBAN HEAT ISLAND	
ID Measure	U1T_innov	U1g_innov	U1k_innov

ACTION n° 4 TITLE: GREEN ROOF					
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
420				0,36	-1,13

ACTION n° 5 TITLE: NATURAL SHADING					
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
600				0,37	-1,12

ACTION n° 6 TITLE: NATURAL SHADING					
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
641				0,40	-1,06

ACTION n° 7 TITLE: NATURAL SHADING					
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
703				0,24	-1,24

ACTION n° 9 TITLE: GREEN PARKING LOT					
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
672				0,54	-0,97
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point
704				0,40	-0,93

RELATED IMPACT THAT THE ACTION MITIGATES			URBAN FLOODING	
ID Mitigation	NDVI	NDBI	Index UHI: starting point	Index UHI: monitoring point
672			-0,30	0,00
ID Mitigation	NDVI	NDBI	Index UHI: starting point	Index UHI: monitoring point
704			-0,15	0,00

ACTION n° 10 TITLE: GREEN PARKING SPACES WITH FILTER STRIP																				
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND		RELATED IMPACT THAT THE ACTION MITIGATES			URBAN FLOODING											
ID Mitigation				LST_msm		Veg_mq		Build_mq		ID Mitigation			ndVI		NDBI		Index UHI: starting point		Index UHI: monitoring point	
357										357							-0.56		0.00	

ACTION n° 11 TITLE: GREEN PARKING SPACES WITH FILTER STRIP										
RELATED IMPACT THAT THE ACTION MITIGATES				URBAN HEAT ISLAND		RELATED IMPACT THAT THE ACTION MITIGATES			URBAN FLOODING	
ID Mitigation	LST_msm	Veg_mq	Build_mq	Index UHI: starting point	Index UHI: monitoring point	ID Mitigation	NDVI	NDBI	Index UHI: starting point	Index UHI: monitoring point
704				0,40	-0,93	704			-0,15	0,00

ACTION n° 12 TITLE: THE MOBILE BARRIERS									
RELATED IMPACT THAT THE ACTION MITIGATES			URBAN FLOODING		RELATED IMPACT THAT THE ACTION MITIGATES			SEA LEVEL RISE	
ID Mitigation	NDVI	NDBI	Index UHI: starting point	Index UHI: monitoring point	ID Mitigation	Mu > 1m above sea-level	Index UHR: starting point	Index UHR: monitoring point	
354			-0,35	0,00	354		0,01	0,01	
ID Mitigation	NDVI	NDBI	Index UHI: starting point	Index UHI: monitoring point	ID Mitigation	Mu < 1m above sea-level	Index UHR: starting point	Index UHR: monitoring point	
395			-0,11	0,00	395		0,14	0,14	

Dune Costiere Park

WP4 - MONITORING implementation - Parco DUNE COSTIERE

ACTION n° 3 Restoration and Management of Biodiversity in the Park

RELATED IMPACT THAT THE ACTION MITIGATES		COASTAL EROSION	
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
3		0,002269572	0,002269572
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
4		0,005610411	0,005610411
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
5		7,86105E-05	7,86105E-05
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
6		0,000121697	0,000121697
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
28		0,000591621	0,000591621
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
29		0,024406696	0,024406696
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
30		0,049198558	0,049198558
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
31		0,120008743	0,120008743
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
33		0,098693015	0,098693015
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
34		0	0
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
35		0	0
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
36		0	0

ACTION n° 6 Restoration and Management of Biodiversity in the Park

RELATED IMPACT THAT THE ACTION MITIGATES		COASTAL EROSION	
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
3		0,002269572	0,002269572
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
4		0,005610411	0,005610411
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
5		7,86105E-05	7,86105E-05
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
6		0,000121697	0,000121697
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
7	0,00	0,002955513	0,002955513
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
8	0,00	0,024839988	0,024839988

ID Transept Area	Built_Up Areas
9	0,00
ID Transept Area	Built_Up Areas
10	0,00
ID Transept Area	Built_Up Areas
11	0,00
ID Transept Area	Built_Up Areas
12	0,00
ID Transept Area	Built_Up Areas
13	0,00
ID Transept Area	Built_Up Areas
14	0,00
ID Transept Area	Built_Up Areas
15	0,00
ID Transept Area	Built_Up Areas
16	0,00
ID Transept Area	Built_Up Areas
17	0,00
ID Transept Area	Built_Up Areas
18	0,00
ID Transept Area	Built_Up Areas
19	0,00
ID Transept Area	Built_Up Areas
20	0,00
ID Transept Area	Built_Up Areas
21	0,00
ID Transept Area	Built_Up Areas
22	0,00
ID Transept Area	Built_Up Areas
23	0,00
ID Transept Area	Built_Up Areas
24	0,00
ID Transept Area	Built_Up Areas
25	0,00
ID Transept Area	Built_Up Areas
26	0,00
ID Transept Area	Built_Up Areas
27	0,00
ID Transept Area	Built_Up Areas
28	0,00
ID Transept Area	Built_Up Areas
29	0,00
ID Transept Area	Built_Up Areas

Index starting point	Index monitoring point
0,022406134	0,022406134
Index starting point	Index monitoring point
0,073511728	0,073511728
Index starting point	Index monitoring point
0,023145523	0,023145523
Index starting point	Index monitoring point
0,00901919	0,00901919
Index starting point	Index monitoring point
0,010547937	0,010547937
Index starting point	Index monitoring point
0,018973926	0,018973926
Index starting point	Index monitoring point
0,042275511	0,042275511
Index starting point	Index monitoring point
0,014224143	0,014224143
Index starting point	Index monitoring point
0,159972949	0,159972949
Index starting point	Index monitoring point
0,127561531	0,127561531
Index starting point	Index monitoring point
0,052349474	0,052349474
Index starting point	Index monitoring point
0,378585387	0,378585387
Index starting point	Index monitoring point
0,114081572	0,114081572
Index starting point	Index monitoring point
0,702938013	0,702938013
Index starting point	Index monitoring point
0,492650694	0,492650694
Index starting point	Index monitoring point
0,79858349	0,79858349
Index starting point	Index monitoring point
0,091811598	0,091811598
Index starting point	Index monitoring point
0,010095929	0,010095929
Index starting point	Index monitoring point
0,081364544	0,081364544
Index starting point	Index monitoring point
0,000591621	0,000591621
Index starting point	Index monitoring point
0,024406696	0,024406696
Index starting point	Index monitoring point

30	0,00
ID Transept Area	Built_Up Areas
31	0,00
ID Transept Area	Built_Up Areas
33	0,00
ID Transept Area	Built_Up Areas
34	0,00
ID Transept Area	Built_Up Areas
35	0,00
ID Transept Area	Built_Up Areas
36	0,00

0,049198558	0,049198558
Index starting point	Index monitoring point
0,120008743	0,120008743
Index starting point	Index monitoring point
0,098693015	0,098693015
Index starting point	Index monitoring point
0	0
Index starting point	Index monitoring point
0	0
Index starting point	Index monitoring point
0	0

ACTION n° 7

Recovery of coastal dunes

RELATED IMPACT THAT THE ACTION MITIGATES		COASTAL EROSION	
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
6	58,00	0,000121697	0,000371103
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
7	1000,00	0,002955513	0,00699032
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
8	600,00	0,024839988	0,029943425
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
9	789,00	0,022406134	0,028224937
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
10	100,00	0,073511728	0,073511728
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
11	200,00	0,023145523	0,024118992
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
12	0,00	0,00901919	0,00901919
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
13	1111,00	0,010547937	0,015025358
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
17	2222,00	0,159972949	0,297731291
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
18	9090,00	0,127561531	0,562475433
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
19	2000,00	0,052349474	0,070479878
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
20	0,00	0,378585387	0,37760869
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
21	0,00	0,114081572	0,113973784
ID Transept Area	Built_Up Areas	Index starting point	Index monitoring point
22	1111,00	0,702938013	0,762745862

ID Transept Area	Built_Up Areas
23	2222,00

ID Transept Area	Built_Up Areas
24	9090,00

ID Transept Area	Built_Up Areas
25	2000,00

ID Transept Area	Built_Up Areas
26	0,00

ID Transept Area	Built_Up Areas
33	2000,00

ID Transept Area	Built_Up Areas
36	0,00

Index starting point	Index monitoring point
0,492650694	0,576307224

Index starting point	Index monitoring point
0,79858349	1,327484977

Index starting point	Index monitoring point
0,091811598	0,103818445

Index starting point	Index monitoring point
0,010095929	0,010095929

Index starting point	Index monitoring point
0,098693015	0,098665746

Index starting point	Index monitoring point
0	0

Municipality of Misano adriatico

WP4 - MONITORING implementation - Municipality of Misano

ACTION n° 1 TITLE: Reduction of cooling demand in tourist accomadations

RELATED IMPACT THAT THE ACTION MITIGATES

ENERGY DEMAND FOR COOLING

ID Census area	LST_mean	Vegetated surface	Impermeable surface
990050000008	35,00	700,00	2000,00

Index starting point	Index monitoring point
0,230872851	0,271178632

ACTION n° 2 TITLE: Improve outdoor microclimate of tourist accomadations

RELATED IMPACT THAT THE ACTION MITIGATES

ENERGY DEMAND FOR COOLING

ID Census area	LST_mean	Vegetated surface	Impermeable surface
990500000001	29,00	1230,00	4560,00

Index starting point	Index monitoring point
0,86521834	0,809006997

ACTION n° 8 TITLE: Urban forest

RELATED IMPACT THAT THE ACTION MITIGATES

ENERGY DEMAND FOR COOLING

ID Census area	LST_mean	Vegetated surface	Impermeable surface
9900500000021	34,00	70,00	10000,00

Index starting point	Index monitoring point
0,69297881	0,32940249

Municipality of Pesaro

WP4 - MONITORING implementation - Municipality of Pesaro

ACTION n° 1 TITLE: Greening brownfield area/ Nature-based Solutions

RELATED IMPACT THAT THE ACTION MITIGATES				ENERGY DEMAND FOR COOLING	
ID Census area	LST_mean	Vegetated surface	Impermeable surface	Index starting point	Index monitoring point
410440000269				0,405004391	0,226233154

ACTION n° 2 TITLE: Recovery dune coastal environment of Area Sottomonte

RELATED IMPACT THAT THE ACTION MITIGATES					COASTAL EROSION IN NATURAL AREAS	
ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures	Index starting point	Index monitoring point
110					0,166250038	0,507392185
ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures	Index starting point	Index monitoring point
111					-0,003880991	0,125598912

ACTION n° 3 TITLE: Implementation of a New school NZEB, with Nbs

RELATED IMPACT THAT THE ACTION MITIGATES				ENERGY DEMAND FOR COOLING	
ID Census area	LST_mean	Vegetated surface	Impermeable surface	Index starting point	Index monitoring point
410440000500				0,405542934	0,214546007

ACTION n° 4 TITLE: Construction of a building complex

RELATED IMPACT THAT THE ACTION MITIGATES				ENERGY DEMAND FOR COOLING	
ID Census area	LST_mean	Vegetated surface	Impermeable surface	Index starting point	Index monitoring point
410440001205				0,280906336	0,046696442
ID Census area	LST_mean	Vegetated surface	Impermeable surface	Index starting point	Index monitoring point
410440001150				0,28907275	0,069333792

ACTION n° 5 TITLE: Recovering coastal's functions

RELATED IMPACT THAT THE ACTION MITIGATES					COASTAL EROSION IN NATURAL AREAS	
ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures	Index starting point	Index monitoring point
105					0,209175587	0,688739039

ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures
106				

Index starting point	Index monitoring point
-0,169614493	0,144129937

ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures
107				

Index starting point	Index monitoring point
-0,278459413	0,182712895

ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures
108				

Index starting point	Index monitoring point
-0,251052817	0,281334217

ID Transept Area	Floristic areas	Pblic beaches	Dunes	Coastal protection infrastructures
109				

Index starting point	Index monitoring point
0,061023748	0,389599366

ACTION n° 6 TITLE: Greening measures

RELATED IMPACT THAT THE ACTION MITIGATES	ENERGY DEMAND FOR COOLING
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ID Census area	LST_mean	Vegetated surface	Impermeable surface
410440000667			

Index starting point	Index monitoring point
0,342482305	0,135591748

3.3 Process limitations

The development of monitoring systems has revealed some limitations within the process of impacts analyzing. These limitations derive in part from the process of impact analysis, in which information bases of reconnaissance type were used. I.E. in the study of the "IMPACT ON TRANSPORTATION NETWORK" or the "INCREASED COMPETITION FOR WATER", the vulnerability classes identified in the provincial area, by the PAI, were used. In these cases, the Monitoring system is referred to the competence of the higher-level body, which produces periodically the data, to monitor the effects and changes on the territory of its competence.

Finally, a further limitation of the procedure used is the reduced number of environmental variables taken into consideration by the algorithm. This means that what emerges from the analysis is the result of a modest estimate of the factors that suggest some environmental dynamics. It is therefore advisable to implement this aspect by carrying out further investigations and studies aimed at corroborating what emerged.

Another emerged limitation in the fill-in of the monitoring system is represented by specific actions that, although inspired by best practices with verified effectiveness, do not change the variables of the chosen algorithm. In these cases, the system seems to be ineffective, therefore it is also necessary to integrate the system with further context studies.

Selected impacts	Monitoring system
	yes
Increased energy demand for cooling,	yes
Impacts on transportation network	<i>no, depend by region competence</i>
Impacts on tourism sector	<i>no, depend by region competence</i>
Increased competition for water	<i>no, depend by region competence</i>
Increased coastal erosion in natural areas	yes
Increased energy demand for cooling	yes
Impacts on tourism sector	<i>no, depend by region competence</i>
Variation in crop yield	<i>no, depend by region competence</i>
Increase of drought	<i>no, depend by region competence</i>
Increased coastal erosion	yes
Loss of habitat	<i>no, depend by region competence</i>
Urban heat Island	yes
Urban flooding	yes

Sea level rise	yes
Urban heat Island	yes
Urban flooding	yes
Sea level rise	yes

Table 4 - List of impacts and relative opportunities to draft a monitoring system

Pilot area	Impacts
Misano Adriatico	Increased coastal erosion
	Increased energy demand for cooling
	Impacts on transportation network
	Impacts on tourism sector
Pesaro	Increased competition for water
	Increased coastal erosion in natural areas
	Increased energy demand for cooling
	Impacts on tourism sector
Parco delle Dune Costiere	Variation in crop yield
	Increase of drought
	Increased coastal erosion
	Loss of habitat
Dubrovnik	Urban heat Island
	Urban flooding
	Sea level rise
Rovinj, Vrsar, Poreč	Urban heat Island
	Urban flooding
	Sea level rise

Table 5 - Ultimate list of elaborated impacts for each pilot area

Bibliography

A. A. Klingebiel, P. H. (1961). Land-capability Classification. *Soil Conservation Service*, 21.

Aguzzi, M., De Nigris, N., Preti, M., & Mallegni, R. (2012). Nuovi indicatori per lo studio e la gestione della costa emiliano-romagnola. *Studi costieri* 2012 - 20: 95 – 109.

Benali, A., Carvalho, A. C., Nunes, J. P., Carvalhais, N., & Santos, A. (2012). Estimating air surface temperature in Portugal using MODIS LST data. *Remote Sensing of Environment*, 124, 108-121.

EPA (2018). Climate Change Impacts by Sector. Available at:
<https://archive.epa.gov/epa/climate-impacts.html>. Last accessed: 11/01/2019.

IPCC (2014). Climate Change 2014: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press.

Kosmas, C. F. (1999). Methodology for mapping environmentally sensitive areas (ESAs) to desertification. The Medalus project: Mediterranean desertification and land use. *European Union, 1888*, 31-47.

Liu, L., & Zhang, Y. (2011). Urban heat island analysis using the Landsat TM data and ASTER data: A case study in Hong Kong. *Remote Sensing*, 3(7), 1535-1552.

Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society*, 108(455), 1-24.

Zha, Y. G. (2003). Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. *International journal of remote sensing*, 24(3), 583-594.

List of ANNEXES

- Monitoring system LP
- Monitoring system PP1
- Monitoring system PP3
- Monitoring system PP4
- Monitoring system PP5