An online system for the monitoring of local climate change adaptation plans

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Abstract

Within the framework of the LIFE SEC-ADAPT project (*Upgrading sustainable energy communities in mayor adapt initiative by planning climate change adaptation strategies*)[1], coordinated by Sviluppo Marche the Regional Development Agency of Marche Region, ISPRA is currently working in order to set up and test an open source Energy and Climate Monitoring System with the main purpose to provide an innovative, user-friendly and freely available tool addressed to verify the progress and the effectiveness of mitigation and adaptation actions which will be adopted by city planners.

In particular, the open source adaptation application was conceived as a tool aimed at allowing technical officers of all project municipalities to insert as input data about the state of implementation of adaptation processes (process-based indicators) and/or climate change impact or vulnerability indicators (outcome-based indicators) and to obtain as output the level of target achievement and the distance to the target objective, as ideated in the Energy and Climate Monitoring System concept.

The System represents one of the first example of online adaptation monitoring tool in Italy and even in the European context. The approach will be easily replicable in other contexts if adapted to the local specific features. Finally, a dashboard will help to organize the results of the monitoring and evaluation performance, thus producing synthetic features and maps illustrating the trends towards the achievement of the targets.

Keywords: monitoring, indicators, adaptation, online system

1. Introduction

Monitoring, reporting and evaluation (MRE) all represent a key aspect of an iterative process: adaptation, in fact, requires regular review in order to verify if the community is adapting well in a dynamic world, to assess what is working well, what is not working and why, and finally to provide regular feedbacks to stakeholders on the progress being made. MRE of adaptation is increasingly recognized as a key aspect of adaptation policymaking and this is reflected in the growing number of MRE systems being designed and implemented at national level in Europe (EEA, 20/2015).

Monitoring, reporting and evaluation are distinct yet closely linked processes. In particular, "monitoring" refers to a continuous process of examining progress made in planning and implementing climate adaptation. The objective of monitoring can be described as being "*to keep track of progress made in implementing an adaptation intervention by using systematic collection of data on specified indicators and reviewing the measure in relation to its objectives and inputs, including financial resources*". "Reporting" is the process by which monitoring and/or evaluation information is formally communicated, often across governance scales […]. "Evaluation" refers to a systematic and objective assessment of the effectiveness of climate adaptation plans, policies and actions, often framed in terms of the impact of reducing vulnerability and increasing resilience. Evaluation usually draws upon a range of quantitative and qualitative data, including those gathered through monitoring processes […] (EEA, 20/2015).

Good planning, combined with effective monitoring, reporting and evaluation, can play an important role in enhancing the effectiveness of adaptation programme, projects and actions, by learning from the past and identifying better solutions for the future. Monitoring and evaluation of a plan is therefore required in order to determine whether the plan is achieving the intended adaptation objectives, targets and benefits and/or is creating negative impacts: learning what works (or not), in which circumstances and what are the reasons that allow to achieve the success in adaptation is critical to ensure the relevance and effectiveness of adaptation strategies and plans. Often overlooked or downplayed, monitoring, reporting and evaluation represent therefore one of the most critical steps in the entire planning process and requires an appropriate design in order to be effective (Giordano et al, 2013).

[1] See for more details the following link: http://www.lifesecadapt.eu/it/

2. Purpose and background

Within the framework of the LIFE SEC-ADAPT project (*Upgrading sustainable energy communities in mayor adapt initiative by planning climate change adaptation strategies*), coordinated by Sviluppo Marche the Regional Development Agency of Marche Region, aiming at contributing to increase climate resilience, accordingly to the European Initiative Covenant of Mayors for Climate and Energy, as well as to promote the shift towards low-carbon and resource-efficient economies of the urban target areas, the italian and croatian municipalities partners of the project are currently working together with ISPRA in order to set up and test an open source Energy and Climate Monitoring System. LIFE SEC-ADAPT also aims to adopt and upgrade the model of the Sustainable Energy Communities (SEC) in supporting the improvement of climate governance, as a best practice for the development of virtuous climate change adaptation process in local authorities under the coordination of regional authorities and development agencies at regional level.

The System has the main objective to provide an innovative, user-friendly and freely available tool addressed to monitor and evaluate the progress and the effectiveness of both mitigation and adaptation actions which will be adopted by city planners and will be created in Italian, English and Croatian language. After the end of the project, the final version of the open source application will be made available to all interested municipalities and organizations. The target user of the System is not just the single Municipality that is interested in the monitoring of its own adaptation actions but also the entire Sustainable Energy Community for a whole monitoring of the actions being implemented at the community level.

Mitigation and adaptation are two different strategies internationally recognized to cope with climate change. While "mitigation" represents the human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs), "adaptation" is defined as the "*process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected clima and its effects*" (IPCC, 2014). The first strategy therefore is addressed to reduce the causes of climate change, the second one focuses on reducing the consequences.

For the specific purpose of adaptation monitoring, various steps have been performed within the LIFE SEC-ADAPT Project before the implementation of the online monitoring system.

First of all, a climate baseline has been defined and a medium-to-long term climate scenario has been developed with reference to the period 2050-2100. Based on a common methodology, all municipalities project partners defined current trends of mean and extreme values of temperature and precipitation. Future climate projections of the same variables were selected and analysed based on four regional climate models (RCMs) taking part in Med-CORDEX international research initiative.

As a second step, climate vulnerability and risks assessment has been performed over the target areas of the project: based on a shared methodology (AA.VV, Ancona Municipality Working Group, 2017; GIZ, 2014), all municipalities performed a quali-quantitative indicators-based vulnerability and risk assessment for the relevant impact/vulnerability sectors.

Finally, each municipality partner of the project defined its own local climate adaptation plan including a political vision, the identification of potential adaptation options, and finally the prioritization and selection of the best options.

3. Methods

3.1 General introduction

Three main steps have been carried out in order to set up the Adaptation Section of the Energy and Climate data Monitoring System:

i. *general design of the structure of the online system*;
ii. *definition of a list of adaptation monitoring indicators*, aiming at the identification of the best adaptation indicators required to monitor the progress of adaptation policies at municipal level;
iii. *implementation of the adaptation section of the monitoring system*, aiming at the drafting and definition of the open source application for adaptation purposes.

In designing the monitoring and evaluation framework for the monitoring system, the following questions need to be answered:

- *are we doing the right thing*? *are we doing things right*? (EC, 2013)
- *how could we demonstrate to the community and to stakeholders that the climate change adaptation plan is working towards a more resilient community*? (Snover et al, 2007)
- *is the plan achieving the strategic objectives previously identified*?
- *is the plan able to continue to do so in the future* (UKCIP, Adaptation Wizard)

In order to define a good monitoring, evaluation and reporting framework, key elements should be identified:

- clearly formulated goals, objectives and output measures;
- clearly defined baseline as reference for MRE;
- availability of data;
- involvement of affected stakeholders (AA.VV, Ancona Municipality Working Group, 2017).

3.2 General design of the structure of the online System

The first step focused on the general design of the structure of the entire system. The following five sections have been therefore identified:

i. Section (0) – Dashboard: it has the aim of creating, modifying and viewing a custom dashboard where it is possible to combine multiple visualization onto a single page, then filter them by providing a search query;
ii. Section (1) – Mitigation: it is addressed to monitor consumption data for the monitoring of CO_2 emissions;
iii. Section (2) – Adaptation: it focuses on the monitoring of effectiveness and implementation state of adaptation actions;
iv. Section (3) – SEC indicators: it is addressed to the elaboration of SEC indicators based on specific indicators values;
v. Section (4) – Action: it has the aim of collecting useful information and data associated to each adaptation action to be monitored (Figure 1).

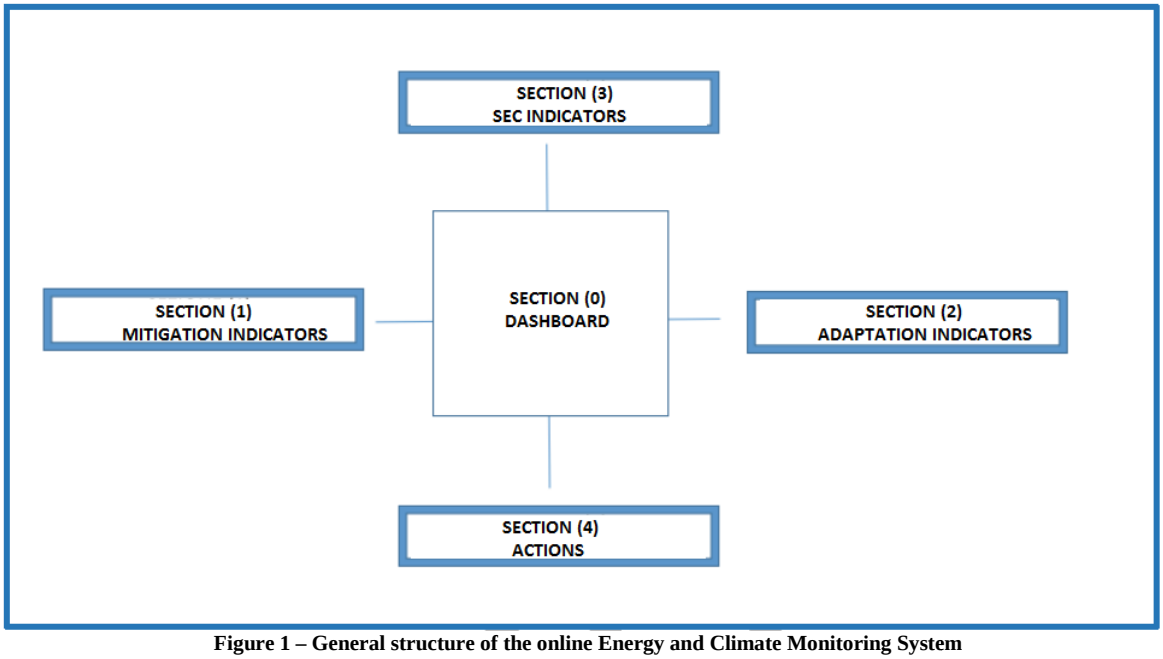


Figure 1 – General structure of the online Energy and Climate Monitoring System

3.3 Definition of a list of adaptation monitoring indicators

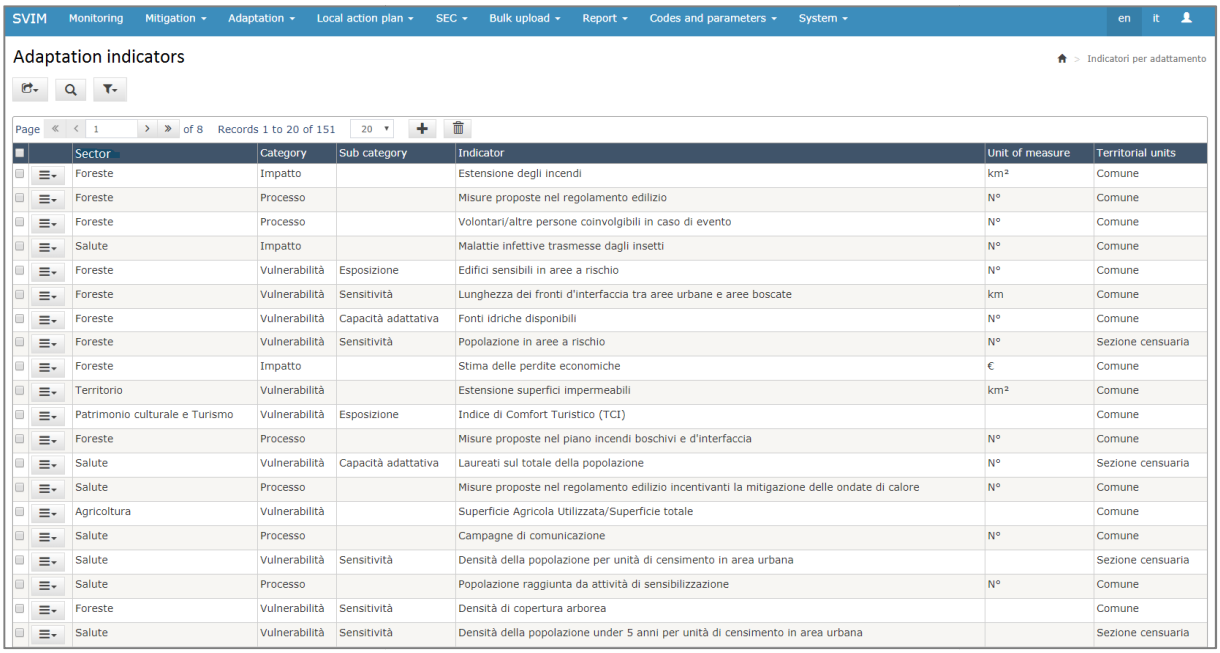
The adaptation section of the Energy and Climate Monitoring System was designed on the basis of indicators and approaches used within the Covenant of Mayors for Climate and Energy and in coherence with the needs posed by the monitoring of adaptation measures identified within the project in order to reduce vulnerabilities and face the risks threatening the target areas.
For this purpose, two different categories of adaptation indicators have been taken into account:

i. process-based indicators;
ii. outcome-based indicators.

In particular, process-based indicators were identified among those indicators aiming at the monitoring of the progress in implementing adaptation measures (building adaptive capacity): this approach considers adaptation as a decision process, rather than a specific action or a series of outcomes. In this case there is no guarantee that successful progress and achievement of the measure will also mean that effective adaptation is taking place. In

addition, outcome-based indicators were selected among those indicators addressed to measure the effectiveness of adaptation policies and measures in achieving the desired outcomes (delivering adaptation actions): this approach considers adaptation as an outcome, while it means building specific capacities, reducing a specific vulnerability or managing some risks and is therefore more challenging (Harley and Van Minnen, 2009).
Based on the results and the key features emerging from the previous steps, the open source application was therefore conceived as a tool that allows technical officers of all project municipalities to insert as input data about the state of implementation of adaptation processes (process-based indicators) and/or climate change impact or vulnerability indicators (outcome-based indicators) and to obtain as output the level of target achievement and the distance to the target objective, as ideated in the Energy and Climate Monitoring System concept. The above mentioned indicators will be easily accessed, managed and monitored at municipal level, in order to make the municipal administrations as much autonomous as possible in the monitoring process of the energy and climate plans adopted.

The screen shown in Figure 2 illustrates an extract from the current list of 150 adaptation indicators foreseen by the monitoring system.



	Sector	Category	Sub category	Indicator	Unit of measure	Territorial units
	Foreste	Impatto		Estensione degli incendi	km²	Comune
	Foreste	Processo		Misure proposte nel regolamento edilizio	N°	Comune
	Foreste	Processo		Volontari/altre persone coinvolgibili in caso di evento	N°	Comune
	Salute	Impatto		Malattie infettive trasmesse dagli insetti	N°	Comune
	Foreste	Vulnerabilità	Esposizione	Edifici sensibili in aree a rischio	N°	Comune
	Foreste	Vulnerabilità	Sensitività	Lunghezza dei fronti d'interfaccia tra aree urbane e aree boscate	km	Comune
	Foreste	Vulnerabilità	Capacità adattativa	Fonti idriche disponibili	N°	Comune
	Foreste	Vulnerabilità	Sensitività	Popolazione in aree a rischio	N°	Sezione censuaria
	Foreste	Impatto		Stima delle perdite economiche	€	Comune
	Territorio	Vulnerabilità		Estensione superfici impermeabili	km²	Comune
	Patrimonio culturale e Turismo	Vulnerabilità	Esposizione	Indice di Comfort Turistico (TCI)		Comune
	Foreste	Processo		Misure proposte nel piano incendi boschivi e d'interfaccia	N°	Comune
	Salute	Vulnerabilità	Capacità adattativa	Laureati sul totale della popolazione	N°	Sezione censuaria
	Salute	Processo		Misure proposte nel regolamento edilizio incentivanti la mitigazione delle ondate di calore	N°	Comune
	Agricoltura	Vulnerabilità		Superficie Agricola Utilizzata/Superficie totale		Comune
	Salute	Processo		Campagne di comunicazione	N°	Comune
	Salute	Vulnerabilità	Sensitività	Densità della popolazione per unità di censimento in area urbana		Sezione censuaria
	Salute	Processo		Popolazione raggiunta da attività di sensibilizzazione	N°	Comune
	Foreste	Vulnerabilità	Sensitività	Densità di copertura arborea		Comune
	Salute	Vulnerabilità	Sensitività	Densità della popolazione under 5 anni per unità di censimento in area urbana		Sezione censuaria

Figure 2 - Examples of adaptation indicators set up within the adaptation section of the Energy and Climate Monitoring System

As illustrated in Figure 2, the adaptation indicators of the monitoring system are categorized as process indicators, impact indicators or vulnerability indicators, the latter two representing the outcome indicators.
In turn, vulnerability indicators are subcategorized into three different sub-categories, based on the following vulnerability definitions: “exposure” is the only component of vulnerability directly linked to climate parameters such as the character, magnitude, and rate of change and variation in the climate (GIZ, 2014), “sensitivity” is the degree to which a system is affected, either adversely or beneficially, by climate variability or change […], and “adaptive capacity” is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities, or to cope with the consequences (IPCC, 2007).

3.4 Implementation of the adaptation section of the monitoring system

User levels

Three different user levels have been foreseen to access the adaptation section of the monitoring system: the first one is the “administrator” who is in charge of managing the overall System, by enabling and disabling the user accounts and has the right to change the user levels permits. The second one is the “thematic expert”, who is responsible for the management and update of decoding tables. Finally, the “local user” who is in charge of entering and updating environmental data required for the monitoring purpose (i.e. adaptation indicators values, adaptation actions and plans, monitoring report).

Decoding tables

The thematic expert is in charge of defining all the decoding tables useful for the adaptation monitoring. These are, in particular:

i. table of the adaptation indicators previously identified (see paragraph above);
ii. table of SEC indicators, which represent a set of common mitigation and adaptation indicators among the municipalities belonging to a specific SEC (Table 1);

Table 1 – SEC mitigation and adaptation common indicators

1	Total energy consumption
2	Total RES production
3	Carbon footprint (CO_2/year)
4	Budget invested in Mitigation (€/year)
5	Budget invested in Adaptation (€/year)
6	Economic losses from Climate-related extremes (€/year)
7	Number of mitigation actions
8	Number of adaptation actions
9	Number of awareness/Information initiatives
10	Number of citizens involved/affected

iii. table of adaptation sectors (Table 2);

Table 2 – Adaptation sectors of the Monitoring System

1	Agriculture
2	Coastal and marine environment
3	Natural environment
4	Biodiversity
5	Forestry
6	Cultural heritage and tourism
7	Water resources
8	Health
9	Territory
10	Transport and infrastructure

iv. table of units of measure for adaptation indicators (Table 3)

Table 3 – Unit of measures for adaptation indicators

1	Euro (€)
2	Meters
3	Square meters
4	Kilometres
5	Square Kilometres
6	Number of occurrence

Adaptation indicators data entry

The local user will be the responsible of data values entry of adaptation indicators in the online system. For this purpose, the user will be asked to fill out a form, including the following information (Figure 3):

- monitoring year (mandatory);
- municipal entity (mandatory);
- adaptation sector (mandatory);
- adaptation indicator value (mandatory)

and other optional information, if available.

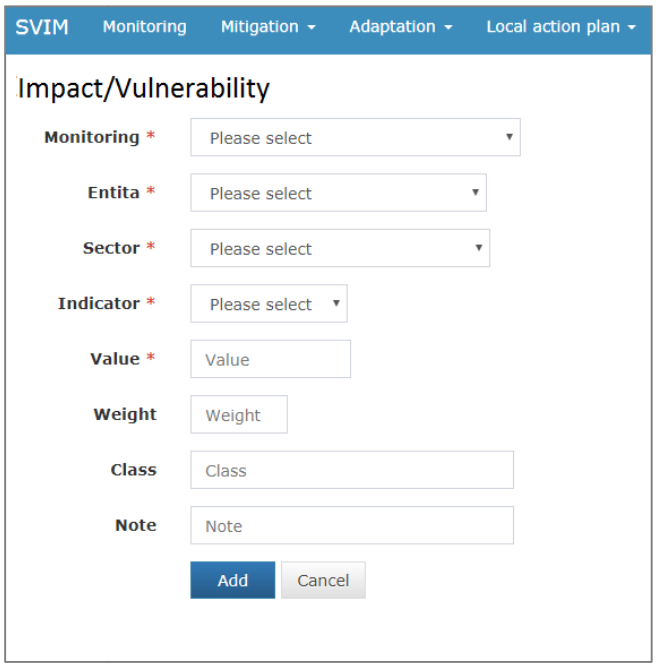


Figure 3 – Data entry form for adaptation indicators values

Adaptation actions and plans information entry

For his monitoring purposes the "Local user" will have the responsibility of entering in the monitoring system information about the Local Adaptation Plan and the full description of the adaptation actions to be monitored. Adaptation actions are described on the basis of various information, as illustrated in Figure 4.

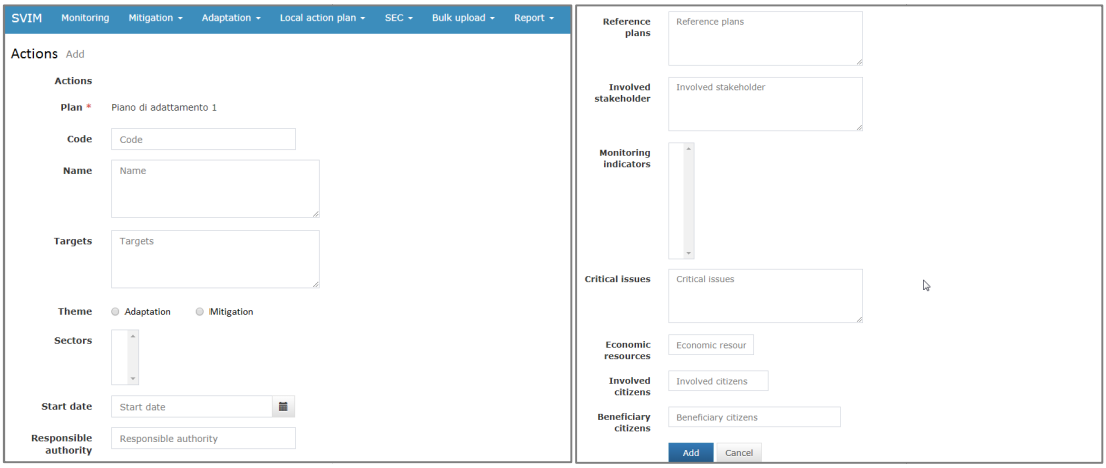


Figure 4 - Information required for the monitoring of adaptation actions

The description of the adaptation action is therefore composed by the following specific set of information:

- action code;
- action name;
- targets description the action is supposed to reach;
- type of action (adaptation or mitigation);
- adaptation sector;
- starting date of the implementation;
- responsible authority;
- reference plans or other documents
- stakeholders involved during the implementation phase;
- monitoring indicators, which are associated to the specific action and required for the process or outcome monitoring;
- critical issues, such as barriers to the implementation;

- economic resources required for the implementation of the action;
- citizens involved in the awareness raising initiatives;
- citizens beneficiary of the action effects

SEC information entry

The online system is also designed for the monitoring of adaptation actions of the entire Sustainable Energy Community (SEC). Each SEC is due to register itself to the system while at the same time accounting for all the municipalities belonging to it (Figure 5).

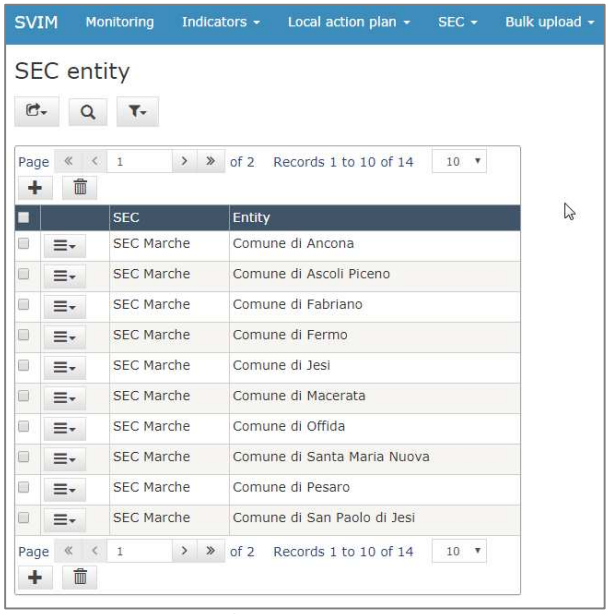


Figure 5 – Example of SEC entities registered to the system

Once the SEC is registered, the system requires that all the indicators identified for the SEC (Table 1) are calculated in order to be able to elaborate the overall values for the SEC.

The process and outcome monitoring

Each monitoring year, the "Local user" will be in charge to enter the information required about adaptation actions and adaptation indicators values in order to complete an Adaptation Monitoring Report. Adaptation indicators values will be compared monitoring year per monitoring year with respect to the "baseline reference scenario" deriving from the results coming from the vulnerability and risk assessment performed during the previous step of the project.

When performed more than two monitoring years, adaptation indicators trends will be visualized in order to be properly analyzed. Based on these trends it will be possible to assess if the adaptation actions associated is really effective or not (Figure 6).

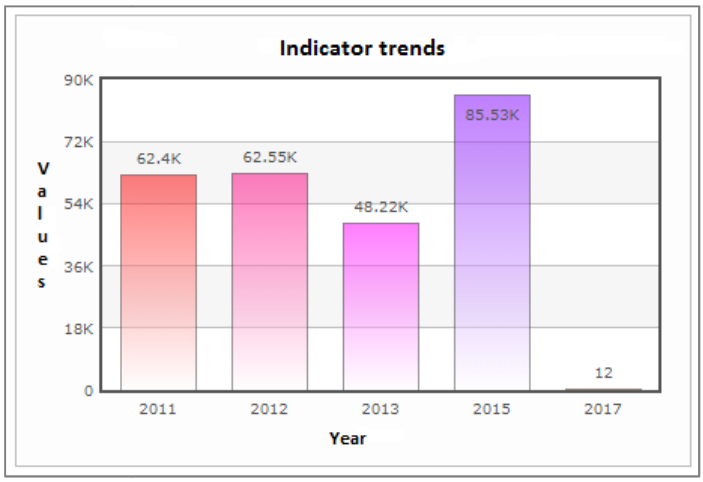


Figure 6 – Example of adaptation indicator trend for the adaptation action monitoring

Furthermore, SEC indicators are summarized on the basis of the single indicator value of the single municipality belonging to the SEC and then analysed and reported through specific filters and thresholds. Thus the system allows to analyse the following issues:

- how much money has been invested on adaptation;
- how many adaptation actions have been implemented;
- how many citizens have been involved during the implementation of actions;
- how many citizens will benefit from the actions;

Each of these indicator can be displayed in a graph representing the trend during the monitored period (Figure 7).

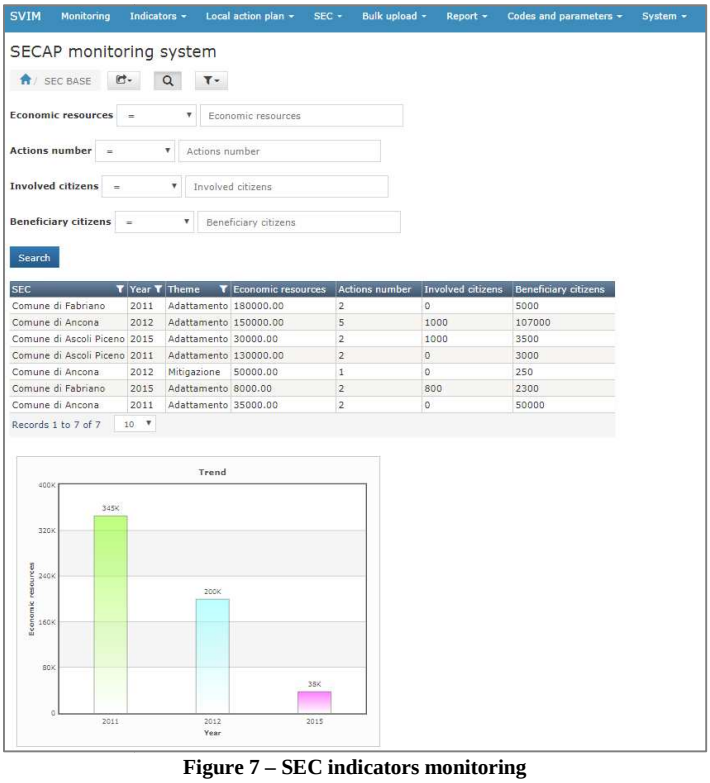


Figure 7 – SEC indicators monitoring

4. Discussion and conclusions

Once the system will be officially set up, each municipality will regularly start to use it by collecting and systematizing key climate-environmental data in order to track the level of implementation and effectiveness of the adopted climate adaptation plan. This opportunity will be available both at local and the entire SEC level.

Barriers for a good performance of the system are identified. First of all, the effectiveness of the tool relies

on the availability of quantitative data of impact and vulnerability indicators. In particular, vulnerability indicators are based on methodological approaches which are not yet standardized. The risk is then to calculate them through different methodologies from one year to another. Standard and common methodological approaches are therefore required in order to ensure that the indicator trend is scientifically sound during time.

Furthermore, municipalities are required to share methodological approaches thus allowing a comparison among municipalities. In particular, SEC indicators will require shared approaches among municipalities in order to be significant.

The system represents one of the first example of online open-source integrated adaptation and mitigation monitoring tool, at least in Italy. The tool will be easily accessible and used, user-friendly and adequately flexible to include new indicators, new energy sources as well as emissions factors for the mitigation side of the tool. The approach will be thus easily replicable to other contexts if adapted to the local specific features. Furthermore, the tool will be accessible via mobile app thus allowing the access and use through mobile devices.

Future perspectives will concern the strengthening of the system's potential in order to make the tool more adequate to the user needs. A specific testing of the system will be required for the purpose.
New developments will be required in order to better implement the dashboard of the system, thus making the visualization and the analysis of data more effective and fit for purpose.

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