Guidelines and management tools: a case study

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Abstract

As it is well known land use in dense populated area is often characterized by competing and fast evolving industrial and agricultural activities introducing various elements of environmental stress that must be taken into account in every planning and management phase.

In this work we discuss the application of a whole new integrated approach to the analysis of a quite strategic district in the Italy's Pianura Padana, showing as the land use constraints and the related conflicts between the involved communities at different space-time scales, can be driven to solution and finally managed thanks to an increased diffuse knowledge and the implementation of innovative perception tools of the various stress elements, making possible the setup of a new guideline system, already implemented, and a higher environmental awareness.

1. Introduction

In many research and operative fields current years will be probably recorded as the beginning of a new era based on the capability of fast and diffuse analysis of great amounts of data, coming from whatsoever source. This is also true with respect to the environment management issues. What the Authors presented as an option a few years ago (see ref. [1,2,3]) it is at present a basic mandatory requirement to carry any problem or issue in landscape management to an acceptable solution. The idea of a mapping of any kind of information describing the status of an area (at various scales) in a proper nth-dimensional mathematical space, transforming all anthropogenic activities in operators acting on portion of that space, can now be coupled with the possibility of a diffused information collection and fast sorting computational tools. The expected result will be a chance for many subjects for both an organized bottom up approach in management and, from the top, the possibility a decision chain widely supported by a sound and active knowledge engine.

2. Methodology and analysis system

The general complexity of a region requires advanced environmental analysis tools that are able to highlight critical issues often latent and not directly observable only through measurement campaigns and ex ante. The US EPA in 1984 started a program to define guidelines to support the decision makers in health risks assessment, determined by toxic and carcinogenic pollutants exposure. The aim of the guidelines was (1) to identify a method for the evaluation of the risk target level and (2) to define reference criteria for acceptable risks. The guidelines allow EPA to calculate exposure to certain pollutants along the standard definition:

$$E = \int_{t_1}^{t_2} C(t)dt$$

E = Exposure during the time interval t_1-t_2

C(t) = Time dependent concentration in the receptor

The calculation can, at least in principle, consider different pollutants (and kind of equivalent exposure sources) but there are some critical issues to be analysed:

a) calculations can enter into difficulties when trying to harmonize the effects coming from different sources acting and contributing to the "exposure" in different way (cumulative risks);

b) the need to identify the various contributions to the risk analysis to support the decision-maker.

To manage these operative aspects a system has been proposed that modifies the calculation of an equivalent exposure as:

$$E = \int_{t_1}^{t_2} C(t)dt \Rightarrow \int_{t_1}^{t_2} Z_{e_iOp_jm_k}^{e_iER-HC-ES}(t)dt$$

$e_iOp_jm_k$ = k-th source that emits i-th pollutant, through the j-th operation

$e_iER\text{–}HC\text{–}ES$ = Receptors (ER: environmental resources; HC: human community; ES: ecosystems)

Above extended definition make easy to identify and take into account every kind of "exposure" source and of dose transfer channels and:

1) evaluate cumulative effect exposure (in compliance with CEQ prescriptions[1]) and the respective sources in near real time, using specific data

2) make the results more usable from institutions, businesses and citizens

3) supporting decision-makers in eventually taking corrective actions

4) and automatically helping in the definition a suitable "Sustainability level" able to take into account both environmental stress configuration and their effects

5) give to administrations a framework for the management guidelines.

3. The Sustainability Model: a Case Study

In the past years it has been elaborated a general environmental model for the district of Montichiari (Brescia Province, Italy) where there is a really critical mix of element of stress (industrial sites, farming, waste landfill and waste burning and disposal sites, main highways, airports) and vulnerability (some paradigmatic cases of unwanted and unforeseen adjacency between urban residential areas and industrial settlements).

Figure 1 shows with some detail the above mentioned situation.

[1] Considering Cumulative Effects under National Environmental Policy Act, Council on Enviromental Quality, CEQ, Executive Offce of the US President, Jan. 1997.

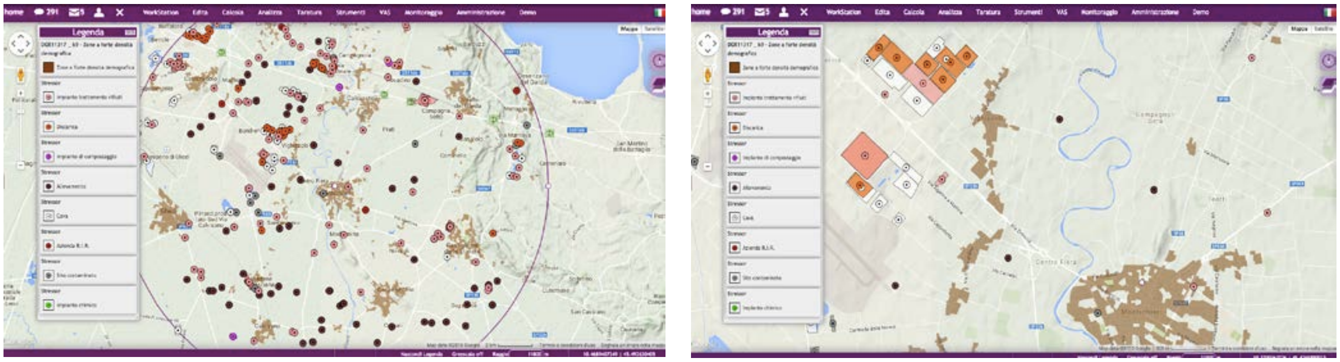

Figure 1: Stressor and residential areas in the Montichiari District and neighbors, focus on the quarrying activities.

To model the impact, 296 emission sources have been considered, for the air domain only, with 267 related to PM10 emissions (characterized also with respect to authorization data), accordingly to the recent prescription by WHO about their carcinogenic effects.

Health risk have been evaluated starting from the “extended” dose analysis, including time depending and delayed cumulative effect. One of the more critical issues resulted from waste disposal sites (usually coincident with the previous quarrying locations), where the effects don’t last, obviously, only for the operational time (and with a granted confinement capability of 30 years, accordingly with the actual regulatory prescriptions) but must be analysed taking into account various potential leaks and dynamic behaviours that could induce risks to be considered for centuries.

We present in the following a few results of the analysis and their influence in terms of active policies and also formal guidelines.

a. Environmental sustainability and air quality

The Air Quality has been evaluated thanks to the PM10 concentration levels measured by the Lombardia Region ARPA service in 2012. The average value is near to the limit threshold of 40 µg/m^3 and the maximum number of allowed overruns on a daily basis for the 50 µg/m^3 limit has been reached in the Montichiari District and all the neighboring municipalities. Also the reference limits given by WHO have been largely exceeded.

b. Sustainability evaluation for the stressor elements of the Montichiari District with respect to standard technical and regulatory limits

The AQ sustainability has been evaluated using the DCGIS-ADMS© tool, to model the influence of the various stressor elements:

(1) with respect to the regulatory Target Level stated by the Italy’s D.Lgs. n. 155/10 *et seq.* (40 µg/m^3), the 7% of the Montichiari District violates the sustainability requirements;

(2) with respect to the WHO Target Level (20 µg/m^3), the 20% of the area is not compliant.

Also a correlation analysis between emissions and residential density has been performed taking into account the area up to 7.5 km from the Montichiari town center, obtaining a not compliance with respect to regulatory standards and WHO requirements of 86 and 315 ha respectively.

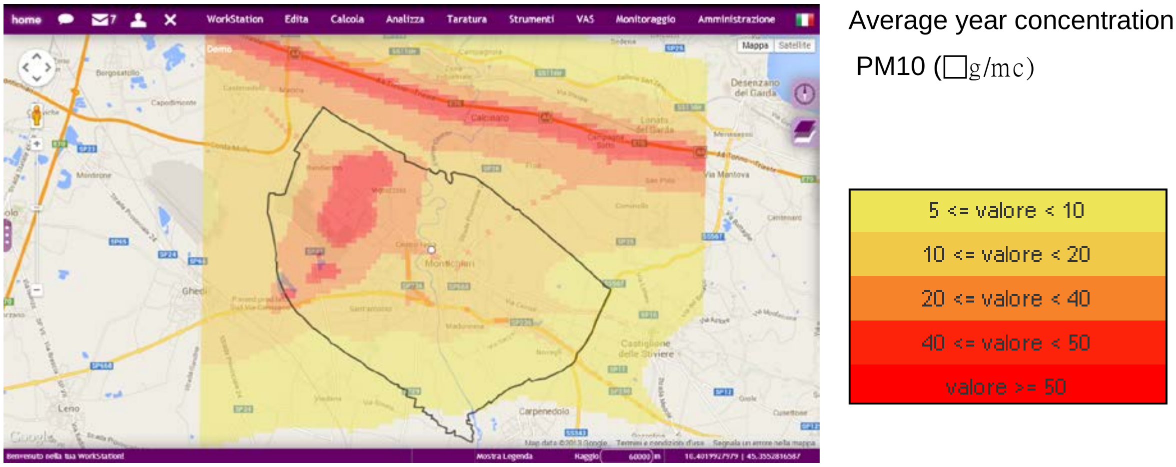

Figure 2: Distribution of PM10 average concentration, Montichiari District.

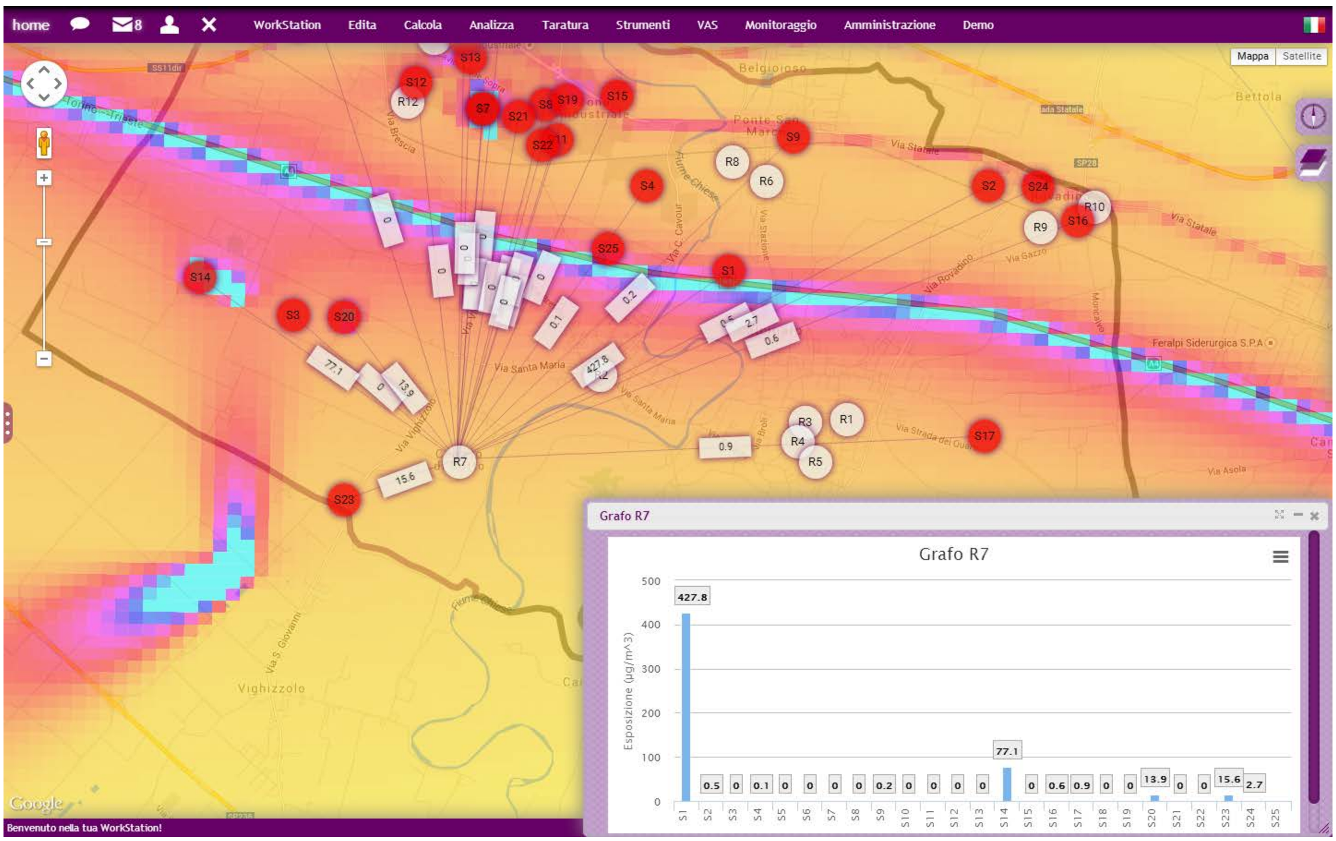

Figure 3: Average PM10 impact distribution normalized to receptors including neighbors.

c. Health risk analysis

To evaluate the consequences at health level, we used a standard tool, the code FRAMES[2] (FRAMES - *Framework for Risk Analysis Multimedia Environmental Systems*) [4] that follows the guidelines suggested by the US EPA and the DOE.

[2] See ref. report: 10/M/2013, "Analisi mediante il codice FRAMES degli effetti dei processi di rilascio di inquinanti in alcuni casi paradigmatici", M.Sumini, F. Teodori, G. Magro, S. Pellegrini, S. Scarpanti.

The model for the Montichiari District has been built from local specific environmental data, each considered with his estimated uncertainty distribution, and allowed the evaluation of the time evolution of the risk related mainly to long term waste disposal sites degradation.

4. Conclusions

The key point of the analysis, even if really detailed and complete, is however not (or not only) in codes and numbers (even if it results a little astonishing in terms of the extent of the estimated environmental damage and the related health risk in the specific case): the main index of success has been the choice of an open access to the environmental data and the model results, offered to the District's inhabitants and allowing them to directly evaluate their own environmental vulnerability. This option has given birth to the idea of the development of a diffuse environmental social network (Q-cumber, see [5,6,7,8,9]) that could represent (and already will, at local and Regional level) an effective tool to help administrators, citizens, business actors to contribute to the whole picture and autonomously evaluate their role in the maintenance of acceptable compliance level with respect technical and regulatory issues.

5. References

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