MUNICIPALITY of ANCONA

SASAKAWA AWARD for Disaster Reduction 2011

Convince local government to make your city resilient to disasters

EARLY WARNING CENTRE
Landslide Department • Municipality of Ancona
### SUMMARY

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1. ANCONA IS GETTING READY!

The city of Ancona (Italy) is the capital of the Marche Region, and counts slightly more than 100.000 inhabitants. It hosts one of the most important ports in the Adriatic region for passengers, freights and fishing. The urban environment is characterized by a not very high density of population (814.97 ab/km²), and a very faster and spread building development. The city borders are defined by the Adriatic sea and by a hilly area tightly connected to the Monte Conero promontory.

On 13th December 1982, a large and deep landslide interested the northern area of the Ancona, namely the "Montagnolo hill". The hill started sliding towards the sea, destroying private houses, public buildings and important infrastructures. The event involved about 180 millions of cubic meters of soil and rock. The event struck all Community and produced strong impacts socially, environmentally and economically as well. The Entire City System was blocked for a long time. After that disaster, Local Community (Institutions, NGO, Universities, Experts, Civil Society, etc) cooperated to rebuild the area of City which was destroyed. The Municipality developed and implemented new monitoring tools and new sustainable strategies at Community level in order to reduce the exposure and vulnerability of the City to the Disaster connected to the impacts of Climate Change.

Nowadays, the City of Ancona is a complex, dynamic, culturally-active reality, which is gradually changing, presenting various criticalities and issues, from the social and environmental point of view. Even though Ancona is a small/medium city, either for number of inhabitants or dimensions, it has to manage the typical issues of the big cities.

Actually the Municipality is really involved in defining a Sustainable Integrated Urban Managing Strategy for increasing the resilience of the City by implementing mitigation and adaptation projects and actions in order to reduce contemporarily CO2 emissions and the disaster risk exposure connected to the Climate Change impacts.
As following, the main key-steps which the City of Ancona made for the sustainability:

2000: the **Agenda 21 process started up** with the activities for the research and elaboration of the data concerning the urban system and the setting-up of A21 Agency. The **first Local Adaptation Plan of Ancona 2012 was made.** Within the LAP, a very important section was reserved to the implementation of risk disaster reduction strategy.

2002: establishment of the **LA21 AGENCY** for Monitoring the implementation of the Local Action Plan ANCONA 2012.

2004: the **signature of the Aalborg Commitments** which required a strong political commitment to energising decision-making processes through increased participatory democracy.

2006 - 2008: **Partner in MUE25 project** ([www.mue25.net](http://www.mue25.net)) (Strategic Monitoring tool for the Aalborg commitment implementation)

2006: the **implementation of the Sustainability Report 2006** to guarantee an effective integration of the sustainability evaluation in the decision making procedures. The Sustainability Report of the Municipality of Ancona, according to the UNEP/GRI (Global Reporting Initiative) guidelines, has been completed and published in the Autumn 2006.

2007: signed the **ADRIATIC ACTION PLAN 2020** for a shared Strategy of Sustainable Development. The Action Plan was signed by other 24 Municipalities of the Adriatic Region.

2006-2008: Implementation of the **Early Warning System** for the reduction of the Landslide risks

2008: the Municipality of Ancona is **partner of the Sustainable Energy Campaign** and in the same year signed the **Covenant of Mayor**, Implementing its own first Energy Master Plan. Actually the Municipality is working for submitting its SEAP - Sustainable Energy Action Plan

2010: Ancona lunched the **Project ACT - Adapting to Climate Change in time** which aim to develop through an inclusive and participated process, shared by all the local actors involved, a Local Adaptation Plan able to forecast and mitigate environmental, social and economic impacts of climate change on the most vulnerable sectors of the European cities in the Mediterranean basin


The City of Ancona is getting ready!
2. ORGANIZATIONAL PROFILE AND POLITICAL SUPPORT

Last 14th December 2010, during the international conference “ACT! Strategies and experiences to increase Urban resilience to climate change” hosted in Ancona within the framework of the ACT Project, the Mayor of Ancona, Mr Fiorello Gramillano, on behalf of the City Council, signed up the world Disaster Reduction Campaign 2010-2011, assuming the ten-point “ten Essential for City Resilience” as priority goals to achieve for making Ancona a more resilient City. This has been an important and strategic step for the City as well as a strong signal of political commitment for the entire community.

By supporting the Campaign the Municipality of Ancona has taken the commitment to put in action integrated policies and strategies for the disaster risk reduction involving all Community toward a bottom up process. Truly, most of the ten-point mentioned in the signed chart were already essential points of the Administration strategy, but not included in a very integrated Local Adaptation Strategy against Climate Change. In fact, many times, adaptation is already taking place but in a piecemeal manner. A more strategic approach is needed to ensure that timely and effective adaptation measures are taken, ensuring coherency across different sectors and levels of governance. Adaptation needs to be mainstreamed into all local policies.

For this reason, in the last two decades, immediately after the terrible disaster caused by the landslide in 1982, the City has tried to enhance its adaptation strategy in order to reduce the risk of new future disasters and to increase the vulnerability of the territory. Lots of human and financial resources were addressed to support the reconstruction of the City and to develop new policies for managing better the impacts of
Climate Change. High investment in new advanced technologies and in maintaining critical infrastructures have been done for straightening the capacity of the City to face the impacts of Climate Change and to reduce the risk of disasters. Most relevant changes has been done also in terms of legislation, introducing more strictly and specific regulations on local urban planning as well as on monitoring climatic phenomena. Therefore, toward the sign of the Campaign, the Municipality tried to consolidate mostly its experiences in implementing risk reduction strategy at local level, both aiming to increase the citizen awareness and to better integrate the disaster risk considerations into a wider and more structured Local Adaptation policy and strategy.

Following this approach, in 2010, the Municipality of Ancona, in the framework of the White Paper - “Adapting to Climate Change: Toward a European Framework for action” [COM(2009) 147] has launched as leader a new co-funded European project namely ACT - Adapting to Climate Change in Time (www.actlife.eu). The Project ACT aims to demonstrate that through an inclusive and participated process, shared by all the local actors involved, is possible to develop a Local Adaptation Plan able to forecast and mitigate environmental, social and economic impacts of climate change on the most vulnerable sectors of the European Cities in the Mediterranean basin. Partner of the project are the two Cities of Bullas (ES) and Patras (GR), the National Institute for the Environmental Research (ISPRA) and the Forum of Adriatic and Ionian Cities (FAIC). The project budget is around 1.800.000 euro and it will be closed in the end of 2012.

The main objectives of the project are perfectly in line with the Hyogo Framework for Action. In fact the ACT project aim at:

- developing a process to create a local adaptation strategy. This process will lead to the identification of areas of intervention and specific actions to undertake by directly involving a wide range of local actors that represent all sectors that will be affected by climate change (urban planning, constructions, water management, hydro-geological risk management, health, industrial risk management).
- Involving (by increasing their awareness) local actors (local industries, citizens, health system, civil protection, etc.) in the development of local adaptation strategy. This will allow to select proportionate, appropriate and cost-effective measures to be included in the adaptation strategy.
- Creating and disseminating guidelines that can encourage other European communities (in particular in the Mediterranean basin) to adopt the same process and to develop their own local adaptation strategies.
- Enhancing the competence of local authorities in understanding the effects of climate change, and hence in planning and implementing policies and actions to adapt to them.
- It establishes a baseline scenario by scaling down a regional climate change scenario for the Mediterranean basin against which to assess specific environmental, economic and social impacts.
- Providing the cities within the Mediterranean area, characterized by different territorial, socio-economic and climatic conditions, with a shared methodology for local impact assessment.
- Recommending where emergency plans should be formed for low probability, but high consequences risks.

The Community involvement in defining Local Adaptations and risk Reduction policies is actually one of the main objective of the Ancona Administration. As following a brief profile of the Organization:

<table>
<thead>
<tr>
<th>Name of Organization:</th>
<th>Municipality of Ancona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main field of Activity:</td>
<td>Energy, Urban Planning, Social and Cultural Sector, Tourism, Risk Disaster Reduction, Environment and Mobility, Public works, Climate Change and Agenda21</td>
</tr>
<tr>
<td>Size:</td>
<td>900 employees</td>
</tr>
<tr>
<td>Name of the Mayor:</td>
<td>Prof. Fiorello Gramillano</td>
</tr>
</tbody>
</table>
3. THE NATURE OF WORK CARRIED OUT

3.1 THE LANDSLIDE EVENT

On 13th December 1982, a large and deep landslide interested the northern area of the Ancona, namely the "Montagnolo hill". The hill started sliding towards the sea, destroying private houses, public buildings and important infrastructures. The event involved about 180 millions of cubic meters of soil and rock. The landslide had an extension of 220 hectares, around the 11% of the urban area of Ancona.

Figura 2 - Landslide Map (2010)
Entire residential districts (Posatora and Borghetto) were completely evacuated. Important and strategic buildings such as the Faculty of Medicine, the Oncological Hospital, the Geriatric Hospital and the retirement home were definitively destroyed. All the older people and patients were moved to the nearest hospitals for the first aid. Around 1,562 people found accommodation in hotels and residences, remaining there for a long time. Totally, more than 3,000 people were evacuated from the area.
Figura 5 - Old Lady with Firemen (1982)

Figura 6 - Houses and buildings after the event (1982)
Figura 7 - University of Medicine; Oncology and Geriatric Hospital; nursing home for elderly “tambroni” (1982)

Figura 8 - Piazza Padella (1982)
The two main infrastructures of connection, the national railway (Bologna - Lecce) and the access road SS19 (Flaminia), were interrupted as well as the gas and water supplies. The City remain for some days without the necessary services.

Figura 9 - The national railway and the motorway after the disaster (1982)
Figura 10 - The main access road SS76 (Flaminia) after the disaster (1982)

Figura 11 - roads and buildings after the landslide (1982)
Fortunately, no people died during the event!
The more significant damages can be resumed as follows:

- 220 hectares extension (affecting 11% urban area of Ancona)
- 3661 people evacuated (1071 families)
- 1562 people moved to hotels and other residences by Municipality
- 280 buildings destroyed or damaged (a total of 865 residences)
- Faculty of Medicine building, Oncological Hospital, Geriatric Hospital, Tambroni retirement house, were irreparably damaged
- 31 farms
- 101 SME
- 3 industries
- 42 shops
- 500 people lost their job
- National Railway MI-LE (Adriatica) and regional Highway Flaminia blocked
- Gas and water supplies interrupted

The dynamic of the landslide can be explained in two phases:

- A gravity slide happened at great depth, probably induced by some dislocation activated during the 1972 earthquake, than re-activated by an intense rain infiltration (some days before the event, it rained for almost 6 days without interruption).

- An activation of superficial and medium landslides. These started to move after about 10 minutes, with consequent damages to buildings and infrastructures

The superficial geomorphology of the Ancona landslide influences by any and complex movements. The colluvial soils, in some places of the landslide, where their thickness is about 10m, have flown down as a mudslide. This dynamic was helped by the high rate of saturation. By considering all the researches and investigations did during the last 25 years spent in the site and in laboratory, we can conclude that the Great Landslide of Ancona City is a Deep-seated landslide (complex, composite according to Cruden & Varnes 1996) reactivated after a long period of precipitations which strongly impacted on the land fractures opened ten years before by a long period of earthquakes (6 months duration). (fig.11)
In fact, the landslide involves clay and silty clay layers (Pliocene-Pleistocene), fractured with different OCR parameter, alternated with thin sand levels. Overlapped sliding zones are active (maximum depth: 100-120 m, maximum depth 1982 event is 75 m bgl).

Across all the body of the landslide, in horizontal direction, parallel to the coast, there are natural trenches that cross the slope. These trenches are upstream of old landslides slid down and now they are filled with heterogenic and plastic soils. These soils involve clay and silty clay, mud and thin sand level with some fragments calcarenitic layers.

These trenches together with a complex structural system of fracture and discontinuity, influenced the system of underground water. All the geological and geotechnical analyses of the landslide mechanisms aimed at the consolidation preliminary design in the 2000; but this plan concluded that a consolidation was impossible, both due to very large expenses and to a very strong environmental impact, which would have totally changed the site appearance with a severe socio-economic impact.

After that, the Local Administration decided to live with the landslide reducing nevertheless the risk for the people living there.

During the last years, some partial interventions of the total preliminary design, for the consolidation stroke, have been made. Two drainages systems were done, one deep based on trenches and wells, and a more superficial one with canals. Reinforced bulkheads were built and in some part of the area reforestations were made. Ancona Administration decided to continue the drainages systems both superficial and deep.

### 3.2 AN INTEGRATED LANDSLIDE MANAGING SYSTEM FOR REDUCING THE VULNERABILITY OF ANCONA

After defining a shared and concerted strategy at institutional level, in 2002 the Marche Region, promulgated a law specifically for the people who are still living in the landslide area, assigning to the Administration of Ancona the responsibility of developing an integrated landslide managing system by implementing:

1. An **Early Warning System** for a hourly monitoring of the landslide area using most advanced kind of geodetic and geotechnical strumentation
2. An **Integrated Emergency Plan** where a codified system of responsibilities and procedures to apply in case of alert were identified for the protection of people and infrastructures.

The developed of the whole system aim to guarantee the population to live safely in their own homes throughout a continuous monitoring of the landslide movements.

### 3.3 THE EARLY WARNING SYSTEM

The project "**EARLY WARNING SYSTEM**" consist of the integration of continuous surface and borehole active monitoring. A surface monitoring system, based on 7 total stations and 33 geodetic GPS (7 references and 26 monitoring points) has been installed since 2008. Recently, it is also integrated with a located Bore-Hole Geotechnical System based on 3 DMS multi-parametric columns installed down to 95 m depth.
3.3.1 THE SURFACE MONITORING SYSTEM

The surface monitoring system is based on:

- 7 Automatic Robotic Stations (of high precision)
- 230 reflector points (installed partly on the 64 inhabited houses and on the structures and infrastructures)
- 26 geodetic GPS (Global Position System - at single frequency L1 (installed on the 64 inhabited houses)
- 8 geodetic GPS at dual frequency L1 + L2 (reference)
- 7 high precision clinometric sensors for the stability control of the main stations of the I and II level of the net (automatic geodetic boxes).

The combination of the different instruments: GPS, Automatic Robotic Stations and the clinometric sensors allows us to monitor in the 3D (3D, X, Y, Z) a great number of points previously identified, to keep them under supervision with different measuring technical and from different, control positions. The adoption of the geodetic GPS at dual frequency assure an high quality of the GPS measures, and a greater versatility at all the system.

This monitoring system is studied to try to determine every surface movement both in the area and in the inhabited houses and to produce some alarms managed by a Control Centre H24 placed in the Town Hall, where a staff of technicians have to estimate the alarms. Only whenever the situation requires the Coordinator starts the Civil Protection Plan. The measuring cycle is set up on 30 minutes, but in emergency or after a long rainy period, the system can operate on every points of the dual frequency GPS net also in Real Time RTK, and with the 7 Automatic Robotic Stations. (Figure 13)
The surface monitoring is based on GPS system developed into 3 different active levels, on 7 Automatic Robotic Stations and a Remote Control with 7 high precision clinometric sensors for the stability control of the main stations of the 1st and 2nd level of the net:

A - GPS system:

- Main Network (1st level active at the moment) formed by n°3 main stations outside of the landslide area with N°3 geodetic GPS at dual frequency L1+L2 (reference) placed on two steady buildings, and a third one placed on a Geodetic box at Marina Dorica founded with a reinforced concrete pole (18 m).

- Secondary Network (2nd level active at the moment), formed by n°5 main stations inside of the landslide area with n°5 geodetic GPS at dual frequency L1+L2 (reference) placed on one building and on n°4 Geodetic boxes founded with reinforced concrete poles (12-18 m). All these geodetic GPS (n°3+n05) form a high precision net working in the Early-warning system, on different control levels, to assure the GPS net (at single frequency L1), installed on 26 inhabited houses, a strong network; so that after an alarm it can work in real time RTK.

- Third Network (3rd level active at the moment) formed by N°26 Geodetic GPS at single frequency L1 installed on 26 inhabited houses inside of the landslide area.

B - Automatic Robotic Stations:
The Automatic Robotic Stations (n°7 of high precision) are placed in the I and II level networks, in the same places of the geodetic GPS at dual frequency L1+L2, except for the "Collodi school" building. They control (angles and distances) of 230 reflector spots placed on the inhabited buildings left and on the consolidation structures built inside the landslide.

3.3.2 THE GEOTECHNICAL MONITORING SYSTEM (DMS)

The located Geotechnical Monitoring System DMS (patents and trade mark CSG srl - Italy) was installed in February 2009. It is composed of 3 Modular Dynamic System columns positioned inside a 100m depth borehole. Each column is formed by 85 Biaxial Inclinometric modules (range +/-20°, resolution 0.01°), by 2 Piezometric Sensors (range 100 psi, resolution 0.01 m) and by 85 Temperature Sensors (range 0-70°C, resolution 0.1 °C). Each column has an active length of 85 metres where monitoring instruments are placed. The first ten metres and the last five ones are without any instruments. Digital compasses are also on board.

DMS columns have been preassembled and installed in site (Figure 3) with DMS REELER, connecting the required number of modules, each containing one or more geotechnical-geophysical sensors and the electronic boards for data.

The modules are linked by special 2D/3D flexible joints that allow strong, continuous adaptability to bends and twists of the borehole, whilst maintaining rigorously the orientation with respect to a reference system defined during installation.

3.3.3 DMS EARLY WARNING MANAGEMENT

The data from the DMS instrumentation column are sent through RS485 protocol to the control unit, which compares them with threshold values (set by the user) and storages them in a circular buffer. In case of movements larger than threshold values, the control unit sends a warning SMS/direct call to the staff on
duty of the monitoring centre. The same is the case of rapid change of watertable levels. Warning levels are counted from 1 to 4, in a growing order of danger. In the monitoring centre, the control software GeoMaster takes care of downloading the data stored in the control unit memory buffer. The DMS Early Warning is the software that visualizes the subsurface data at the monitoring centre and wherever an Internet connection is possible. The software in a compact check panel allows the contextual control of displacement (E-W, N-S, Module diagrams, on Polar and Azimuthal plots) as well as the variations of the level of the water table and temperature; time history of each multiparametric module, and displacement-velocity are also displayed at selected intervals.

3.3.4 TRANSMISSION SYSTEM

The transmitted data coming from different sensors, are collected according to the two following procedures:

- **1st and 2nd Level Net**: data transmission in real time through a WiFi Standard HyperLan to the Town Monitoring Centre. The system is based on a main radio line (spot to spot) between the Automatic Robotic Stations and the Ancona Municipality Monitoring Centre. Data transmission in real time works through some free frequencies radio links of 5,4 GHz (HyperLan). It realizes a strong transmission and a low environmental impact thanks to their noise controls system.

- **3rd Level Net and in DMS system**: data transmission through periodic GSM in CSD mode.

After some months of observation and data analysis of the surface monitoring system, apart from any ordinary variations connected to the days and seasons, some little movements have been found. Some geodetic GPS at single frequency L1 installed on 26 inhabited houses inside the landslide area (third network) have collected movements of 0,5 - 1,5 cm towards N (slope direction) (Figure 5). The interested area is where the landslide has the maximum depth (100 - 120 m) and where lots of plastic soils into the two trenches are found. But the movements examined are not so relevant because they are localized in a restricted area, during seasons changes (summer-winter), when the clay soils loose their humidity and reduce their volume. These data have permitted to verify the monitoring system sensibility also for what concerns the smallest movements in the colluvial soils.

**Figure 15 - Hourly Data Analysis**

**Figure 16 - Hourly Data Analysis on a building**
3.4 ORGANIZATIONAL SYSTEM and the INTEGRATED EMERGENCY PLAN

Along with the implementation of the Early Warning System, an integrated emergency plan has been developed by the Civil Protection Department of the Ancona Municipality. The Plan is updated biannually and it defines clearly which procedures must be applied in case of alert and who are the persons and organism in charge for the intervention. In fact, within the plan is clearly specified who are the persons in charge and what roles they have.

Within the Municipality a permanent dedicated structure, namely Early Warning Center, was established in order to manage the Landslide issue. A team of engineers, geologists, technical experts and urban planners work daily together for providing analysis, maps and information on the landslide situation and controlling hourly (H24) the interested area and the signals which came from the monitoring system.

Each task and responsibility is clearly assigned. At Organizational level the Early Warning Centre is positioned under the Public Works Department and is formed by:

- **Luciano Lucchetti**, Head of Public Works
- **Stefano Cardellini**, Geoscientific Director and Landslide team Coordinator
- **Paolo Osimani**, Technical Director for the Surface Early Warning Monitoring Centre
- **Mauro Petrini**, Technical Director for the Geotechnical Early Warning Monitoring Centre
- **Antonio Ninivaggi**, Responsible for the Emergency Plan and Civil Protection
- **Francesco Lewandowschi**, Technical Export for the Surface Monitoring System
- **Maurizio Pandolfi**, Technical Export for the Surface Monitoring System
- **Ribichini Renato**, Technical Export for the Surface Monitoring System
- **Augusto Nicoletti**, Technical Expert for Geotechnical Monitoring System – SMG
- **Gianfranco Orazi**, Technical Expert for Geotechnical Monitoring System – SMG
The Emergency Plan established also a special task-force, namely **Centro Operativo di Controllo (C.O.C)**. The C.O.C acts as soon as the early warming system is sent out. The C.O.C is an *intersectorial and multistakeholder structure* in which are involved experts from other Municipality Departments and Sectors as well as experts of other local Institution and Organizations too. Mainly, the C.O.C acts operatively for applying all procedures included within the Emergency Plan in order to reduce the risk exposure of the citizens and of City as well. It is directly activated and coordinated by the Mayor of Ancona who is responsible for all consequently risk reduction activities implemented after the alert is sent out. He also responsible for the directly communication with all Local Community.

Following the different kind of emergency and alert to tackle, different stakeholders are gradually involved in the action of risk protection. In fact, the Municipality has integrated partnerships with government and civil society, including the private sector, NGO and community-based organization in order to prevent disasters and to guarantee the complete safeguard of the population. On the left, a possible operational scheme for an landslide early warning is drawn.

**Figura 17 – Operational Scheme**

**Figura 18 – Procedure Protocol**

Furthermore *Internal Procedure Protocols* are implemented in order to fix who are the internal responsible for the implementation of the Emergency Plan. On the right picture shows the Procedure Protocol for the evacuation of the interested area which is approved by the Municipality Board Administration.

Moreover, the Municipality has activated a strictly cooperation with the civilians who live nearby the landslide area and could be directly interested by a new landslide disaster. Information and training courses are organized in order to explain them how to proceed in case of alert.

As following the TAB shows how the alarm is sent out with respect of the level of information provided by some aimed indicators and parameters.
## ALERT TAB

<table>
<thead>
<tr>
<th>INDICATORS/INFORMATION</th>
<th>CAREFULNESS</th>
<th>PRE-ALERT</th>
<th>ALERT</th>
<th>PRE-WARNING</th>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEGNAZIONI</strong></td>
<td>new on road surface fissures</td>
<td>on road surface fissures in development with openings &gt; 5 cm and steps</td>
<td>subsidence of roads, detachment and marginal crevasses on land</td>
<td>cracks on houses; cracking noise</td>
<td>Very evident movements of homes and land</td>
</tr>
<tr>
<td><strong>RAIN</strong></td>
<td>rain for most consecutive of 3 days rain &gt; 90 mm in 3 days (hold for 20 days)</td>
<td>rain for most consecutive of 5 days rain &gt; 120 mm in 5 days (hold for 20 days)</td>
<td>rain for most consecutive of 6 days rain &gt; 180 mm in 6 days (hold for 20 days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GPS</strong></td>
<td>displacement of 1 house (validated by the first measures to tca and inspection)</td>
<td>displacement of 2 houses in the same area (validated by the first measures to TCA and inspection)</td>
<td>displacement of more than 2 houses in the same area (validated by inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TCA</strong></td>
<td>displacement of 1 house (validated by the first measures to tca and inspection)</td>
<td>displacement of 2 houses in the same area (validated by the first measures to TCA and inspection)</td>
<td>displacement of more than 2 houses in the same area (validated by inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NIVEL</strong></td>
<td>2 mm displacement (validated by inspection)</td>
<td>4 mm displacement (validated by inspection)</td>
<td>8 mm displacement (validated by inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DMS</strong></td>
<td>piezometric: dms1 &gt; 7 m dms3 &gt; 5 m</td>
<td>piezometric: dms1 &gt; 5 m dms3 &gt; 4 m</td>
<td>inclinometers: displacement of 6 mm in 1 day (validated)</td>
<td>inclinometers: displacement of 6 mm in 3 h (validated)</td>
<td>inclinometers: displacement of 6 mm in 1 h (validated)</td>
</tr>
</tbody>
</table>

**EARLY WARNING CENTRE**  
Landslide Department • Municipality of Ancona
4. RESULTS ACHIEVED

For what concerns the results achieved they can be divided as following:

**Environmental level:**

- Concrete environmental benefits in preserving the existing biodiversity and ecosystem of the affected area. The strong investments in the **Early Warning System** have allowed to make still livable the landslide area reducing considerably the risk of abandonment and deterioration.

- **Identification and prevention of further risks of environmental disasters** related to the landslide and generally to the climate change; The most significant and immediate challenges for the Municipality of Ancona will be related to prevent extreme climate events in order to enhance the resilient of the Urban System.

- Adaptation actions taken during these last ten years, have had an intrinsic mitigation potential that **contributed to the mitigation policies** that contemporarily the City of Ancona have already adopted (energy efficiency in buildings and grids, sustainable mobility, etc). Developing mainstreamed strategy focused on adaptation is becoming more and more important to tackle climate change. Adaptation, by definition, is complementary and synergic with mitigation policies but, differently from that set of policies, is characterized by environmental benefits in the middle-long term.

**Technical level:**

- The development of a standardized methodological process to draw and implement an **Integrate Landslide Managing System**, easily applicable to a wide range of local authorities to reduce risk disaster as well as to forecast climate change impacts on local scale;

- The **straightening of the environmental monitoring system** which is the base for defining an effective risk disaster strategy. The implementation of an advanced and innovative **Early Warning System** ensured the possibility of obtaining relevant information not only on landslide movements but also on several other issues connected with climate change such as rainfall regimes, temperature variations, soil moisture, speed and direction of prevailing winds, short-term variations in regional and local sea-level. Collection of all these information is strictly useful for drawing an aimed and stable adaptation strategy for prevent at local level new possible disasters and to guarantee community with an high level of protection.

- The possibility of defining local adaptation strategies and plans at local level having **hourly updated maps and information on the landslide area and all climatic phenomena** which could have negative impacts on the vulnerability of the City. Urban Planners and Decision makers used them to oriented urban planning in a sustainable way.

- **Better city planning resulting in social, environmental and health benefits.**

**Political level:**

- The Administration are enhancing its capability to forecast the impact of climate change on their community, to evaluate different intervention strategies in order to mitigate these effects taking into account social, economic, environmental and risk parameters.
• The engagement and the involvement of the key actors responsible for the implementation of risk reduction and civil protection actions.

• More Integration of adaptation strategy within existing and future municipal plans, policies, and legislations.

**Community Level**

• **Increasing of the Community awareness on landslide disasters and generally on climate change issue**, building know-how to share and diffuse to other local authorities. Very often, people do consciously and unconsciously carry out vulnerability and risk assessments in their daily lives. They also have their own ways of expressing and articulating their vulnerabilities and the risks they face based on their own environments, social and economic circumstances.

• **Straightening the public private partnership.** In fact the Municipality Expert Team is always working in contact with the private companies which have provided technological components, software and hardware for the entire monitoring system.

• The creation of new jobs possibilities as well as of different professional profiles extremely skilled and trained on the ICT and data transmission.

**5. SUSTAINABILITY OF THE CHANGE**

What the Municipality of Ancona did after the terrible landslide event has been to **gradually educate local stakeholders to work as system for improving the City Resilience**. The efforts made during the past years for implementing an Integrated Landslide Managing System and for reducing the risk exposure of the City, allowed to change culturally the community approach to the risks from Climate Change.

More than ten years ago, the whole Community have chosen to “LIVE WITH LANDSLIDE”. This clear vision addressed the strategies of the Ancona Policy makers along the time and so far. “Living with Landslide” is not a slogan. It is a way of living, which implies that the safety for the population is achieved through a high-quality and comprehensive early-warning system that checks in real time the landslide hazard taking into account multiple sliding surfaces and surface effects. That is in contrast with the more static concept of standard engineering remediation work, which is clearly impracticable for the context of Ancona.

Definitively, the project is the result of the best conjunction between human resources and a more reliable technology in the Early Warning Monitoring field able to assure safety and peacefulness for the people who’s living in the landslide area.

The next big challenge for the Administration will be to enhance the involvement of local stakeholder in defining more integrated and mainstreamed adaptation policies at local level. Actually the Municipality is working for establishing a **Local Adaptation Board** (LAB) which will make, after a local impact assessment, a City Adaptation Plan. The board will be composed by institutional and technical representatives, in order to have all the skills and capacities around a table to take effective and enforcing decisions. This will also rise the potential synergies existing among different sectors, that must be exploited to have a more effective and efficient adaptation plan. The more evident are the synergies between public regulation and private commitment, but also between private companies working in different but linked sectors synergies can develop. To find and exploit them will be a priority of the board.
6. DIFFICULTIES AND OBSTACLES ENCOUNTERED

Many difficulties and obstacles were encountered. Most of them are totally solved, other only partially. The lack of economical and financial resources is the first one. The Implementation of the Early Monitoring System required a huge amount of financial resources which were not always easy to pick up. Important support and contribute was provided by the Marche Region during the reconstruction phase and for the implementation of the monitoring system. But the fund raising remain an important recurrent problem to be solved for guarantee a continuous investments in new technologies and ameliorative solutions.

Another difficulty usually faced is the weak involvement of local communities and Institutions. If not continually stimulated, the key-local actor was not able to work as integrated system within shared and concerted strategies. In this ten years, the Monitoring Centre Team did many efforts to straight the Community involvement, by organizing public events, workshops and public forums dedicated to the landslide issue as well as to the Climate Change topic. But more should be done.

Therefore, the Municipality would like to establish a permanent Local Adaptation Board (LAB) in order to mostly involve the main local stakeholder toward a bottom-up adaptation planning process. For this reason, the Administration, toward a strong Political Commitment, decided to support the UNISDR Campaign and to sigh the chart. They strongly aim at stimulating the whole community to be active part in implementing local adaptation and mitigation strategies.

Technologically speaking, most difficulties were faced in order to allow the different sensors to communicate within an integrated technologically platform. Using different software was not so easy to find the solution.

The latest problem to highlight it that there are no so much consolidated experiences, knowledge and skills on this field so that the exchanging best practices, ideas and good experiences is the unique pathway to follow. There are no alternative solutions, because the matter and the issues to face are new and required a very high skilled technicians with a multidisciplinary knowledge. Dedicated training course is needed.

7. HOW THE AWARD MONEY WILL BE USED?

The Award money will be used to build a Scientific and Historical Landslide Centre where will be organized workshops, seminars and training courses for students on the Climate Changes issue and mainly on how Cities could increase their resilience by adapting themselves to live with the landslide. In the Scientific and Historical Landslide Centre will be possible to pick information, to consult technical and historical documents, pictures and photos as well as to take part on seminars, targeted lessons and high level courses to learn more on landslides and on how to live with them.

Students and citizens will be also introduced on landslides phenomena, toward a learning by doing process. In fact a dedicated field visits will be organized in order to provide them with the possibility to “touch” with their hands the instruments used for monitoring the landslide movements and “look” with their eyes how the system works. Case studies and best practices will be showed and studied in order to educate them on the landslide issues and to contribute to increase the community awareness.

Definitively, local stakeholders, Important experts, professors, geologists, researchers could be involved in organizing theoretical and practical training courses aimed at explaining to students and citizens how active landslides in urban areas can be managed and which technical and technological solutions can be adopted. In fact, the primary strategy to reduce the risk exposure should be to increase the resilience of the system.
A de-localization strategy, which unequivocally brings the affected areas to be decayed and finally desolated, is not the best “exit strategy” or solution to adopt. Furthermore, a strategy of landslide consolidation could be also very onerous and risky because the human actions could produce negative impacts on the local environment and landscape. An integrated adaptation strategy is the only reasonable and sustainable solution. It is possible thanks to the integration of these three main factors:

1. the implementation of new electronic tools which allow to reach very high and precise performance in measuring and monitoring hazard phenomena

2. the development of faster data transmission technologies which allow to increase the time of response and to strengthen disaster preparedness for effective response at all levels

3. the high level of knowledge and skills requested to the technicians who have to manage and control the Early Warning System

For this reason, the Municipality of Ancona would like to use the Award Money for straightening the 3rd point mentioned above. Practical courses will be organized in order to train new technicians and experts to be able to use the Early Warning System and to repair the Monitoring System if possible failures and damages could occur. Of course, the Centre will contribute to create new job possibilities too.

Furthermore, the Scientific and Historical Landslide Centre will be useful to build a culture of safety and resilience at all levels. Following that, the Centre shall also work as historical museum where documents, pictures, photos, maps and historical finds relatively to the terrible landslide of Ancona will be collected. A permanent landslide museum could be a good opportunity for younger to know deeply the history of their City and for the entire community to heal “a wound” still opened.

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