APPLICATION OF GEOSTATISTICS AND GIS TOOLS FOR THE INDIVIDUATION OF FLOODED ZONES DURING EXTREME RAINFALL EVENTS IN THE URBAN AREA OF ROME

CNR - IGAG
Istituto di Geologia Ambientale e Geoingegneria

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Di Salvo Cristina*, Giancarlo Ciotoli*, Francesco Leone**, Francesco Stigliano*, Gian Paolo Cavinato*, Filippo Thiery**, Luciano Cavarra**

(*)Institute of Environmental Geology and Geoengineering (IGAG) c/o National Research Council (CNR). Area della Ricerca di Roma RM 1 Montelibretti, Via Salaria Km 29, 300, 00015 Monterotondo Stazione - ROMA (Italy). cristina.disalvo@igag.cnr.it
(**) Civil Protection Department. Via Vitorchiano, 2, 00189 Roma. francesco.leone@protezionecivile.it

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During the last 5 years, the urban area of Rome experienced at least 7 extreme rainfall events, causing flooding of basements, subway stations and places of historical heritage (Fig.1); during the event of 20th October 2011 one people died and damages are estimated around 8 mln Euro. This storm has been the second in intensity per hour since systematic rainfall records are available in Rome (i.e. 1941) and its return period is estimated about 50 years. Floodings are linked to the urban development and the lack of sewer maintenance, coupled with an increasing number of high intensity rainfall events. Authors present the work-in-progress procedure developed by CNR-Igag and Civil Protection Department to manage flooding events; the work was carried out in the framework of the UrbiSIT project, aimed to provide tools and guidelines for natural hazard evaluation in urban areas.Thanks to the collaboration with local authorities, the 7° Municipality of Rome has been chosen as study area. High resolution surface terrain model (2x2 meters) and the sewer network pattern were processed through a series of ArcHydro® tools in the GIS environment to find areas of topographic low ('SINKS') and relative sub-catchment areas; both are carachterized by their geometric features in the attribute table (i.e. area, volume and fill height). The minimum rain height over the sub-catchment areas that fills each sink over a critical threshold of 40 cm was derived; a reduction coefficient proportional to the sewer trunk dimension has been applied whereas the presence of sewer network can drain part of the rainfall. High resolution rainfall data (10 minutes) of 30 different intensity rainfall events from 2001 to 2011 (coming from the rain gauges network of Hydrographic and Mareographic Institute of Latium Region) have been processed to obtain maps of total and hourly rainfall height by using geostatistical interpolator; maps were compared with weather forecasting satellite images to test the validity of forecast. A spatial and temporal analysis of each event was carried out and descriptive graphs were elaborated. Then, the overlay between rainfall maps and sink distribution allowed highlighting those sinks exceeding the critical threshold. The procedure is actually being calibrated with data of emergency calls (firefighters - VV.F., Municipal police) during the studied rainfall events. This work is aimed to provide a tool for national and local authorities for managing flooding emergency by using storm warnings coming from the Functional Centre of the Civil Protection Department.

Figure 1: flooding of Roman Forum during 20 october 2011

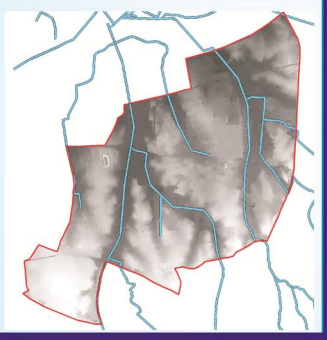
INPUT DATA

TERRAIN DATA

Study area (VII Municipality of Rome

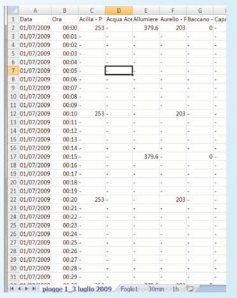
Surface Terrain Model (STM) with resolution 2 m (derived from carthography scale 1:5000)

Sewer network

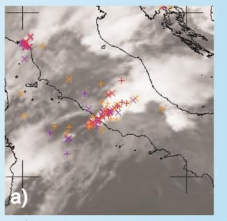


RAINFALL DATA

Rainfall data (every 10 minutes) for 30 high intensity events (2001-2011)



Weather forecast



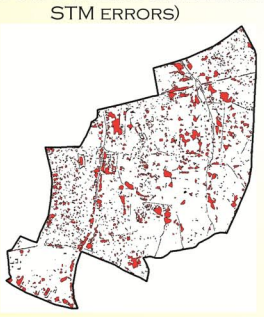
a) Infrared satellite image (from Meteosat 9) showing electric discharges on 20/10/2011 from 7:15 to 7:30 a.m.
b) Monte Media weather radar image, in the range of 120 km (VMI=reflectivity vertical maximum intensity) at 7:30 a.m.

DATA PROCESSING

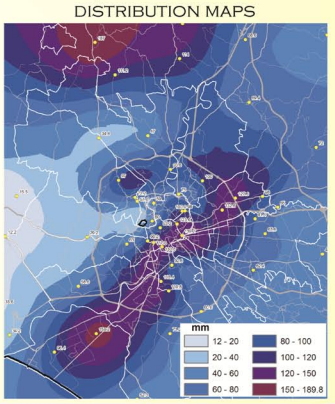
ArcHydro® ENVIRONMENT

DEM reconditioning Surface Model reconditioning by superimposing the sewer network

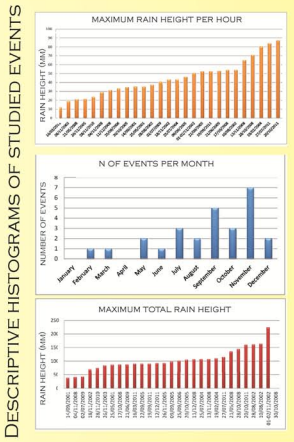
Sink prescreening/ evaluation; depression evaluation
detecting depressed areas and related sub catchments and filling smaller sinks (i.e. STM errors)



Aggregating rain data every 30 minutes; generating rainfall distribution maps



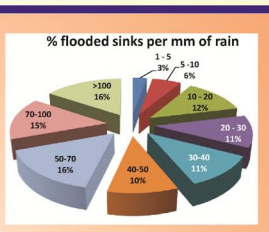
Descriptive histograms of studied events



CALIBRATION AND RESULTS

Calculation of minimum rain height fallen on the sub-catchment which fills each sink over the critical threshold (40 cm)

Rain (mm)	1 - 5	5 -10	10 - 20	20 - 30	30-40	40-50	50-70	70-100	>100
N of sink	75	150	327	296	291	256	411	391	406
%	2.9	5.7	12.5	11.3	11.1	9.8	15.7	14.9	15.5



Simulation of floodings during the event of 20 October 2011

The flooding model is calibrated by using rainfall data and documented flooded areas for 30 sample events

Comparison between modeled and observed floodings, by using firefighters reports and emergency calls
Sinks are selected on the basis of their geometric features: only sinks exceeding a volume threshold were selected, excluding the smallest depressions

APPLICATIONS

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TIME-SPATIAL ALERT FOR THE CIVIL PROTECTION