

*Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile*



*Ufficio Pianificazione, Valutazione e
Prevenzione dei Rischi*

dott.ssa Antonella Scalzo

The 30th December 2002 event at the Stromboli Island, Italy



AEOLIAN ISLANDS



Stromboli

Panarea

Salina

Filicudi

Lipari

Alicudi

Vulcano

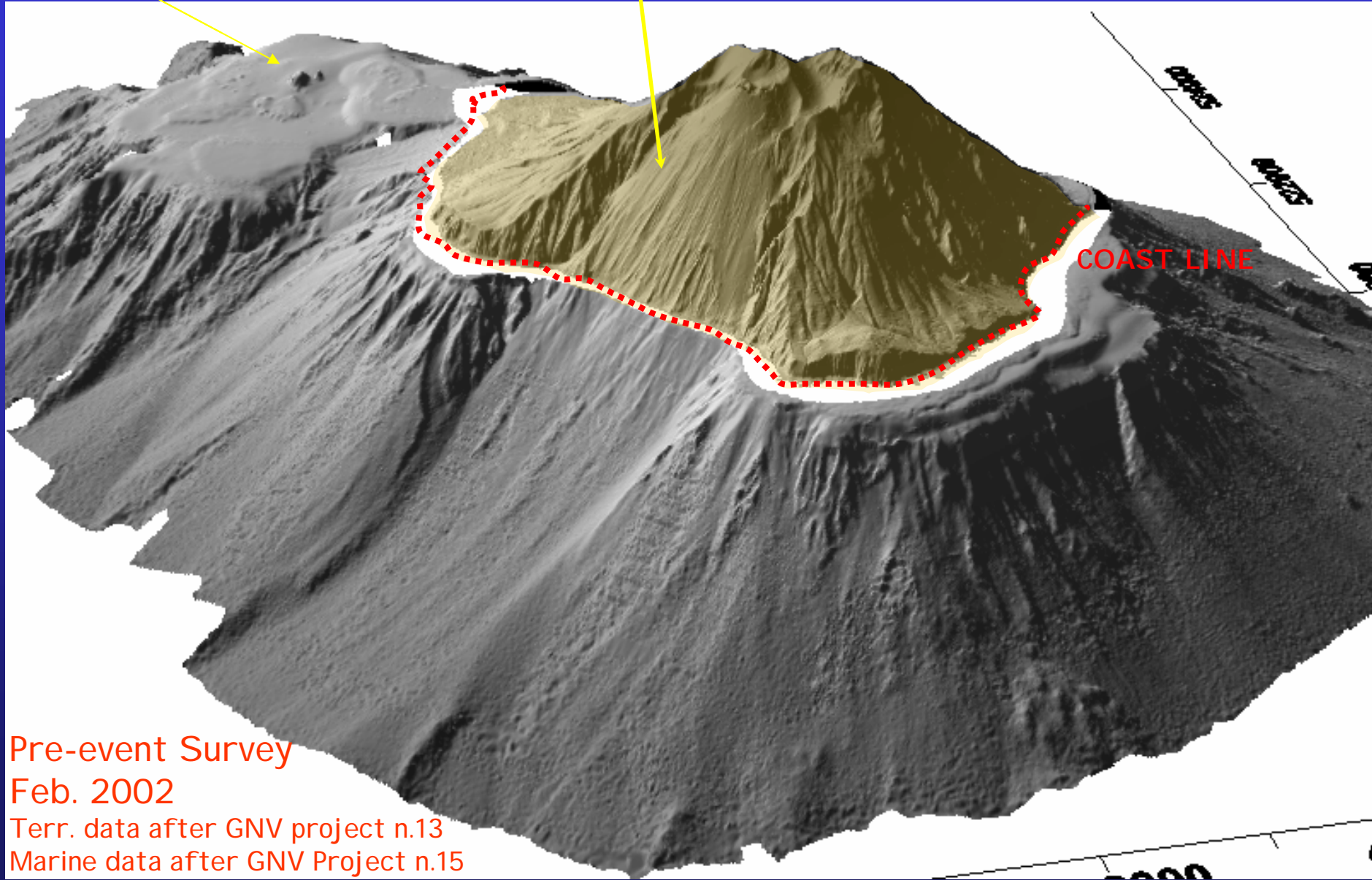
Milazzo

Messina



Strombolicchio neck

Sciara del Fuoco



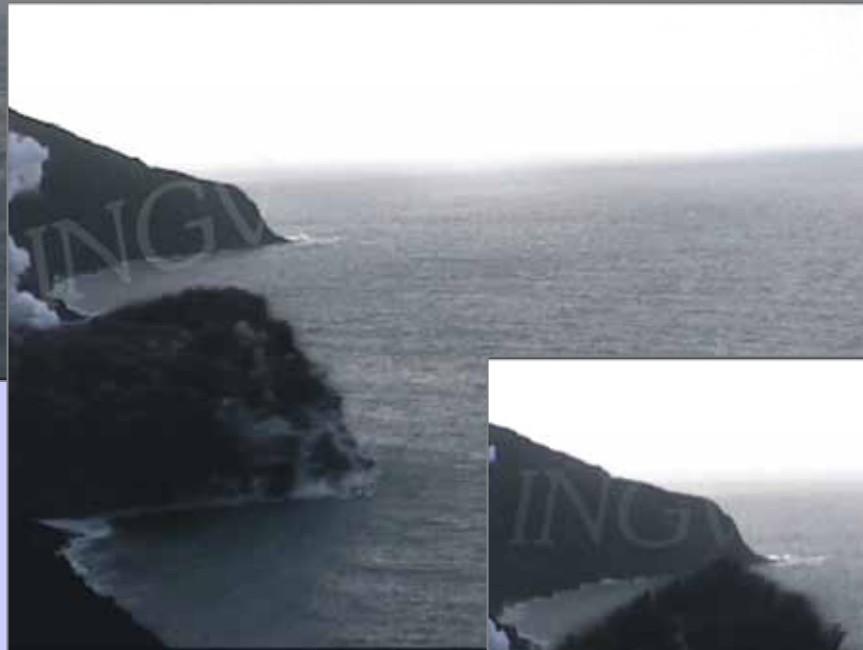
Pre-event Survey

Feb. 2002

Terr. data after GNV project n.13

Marine data after GNV Project n.15

ore 13:12 del 30 dicembre 2002



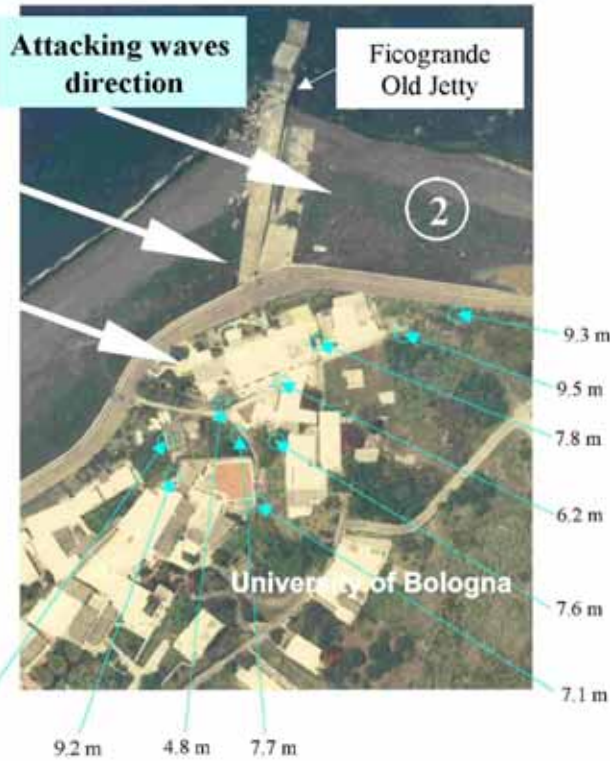


University of Rome



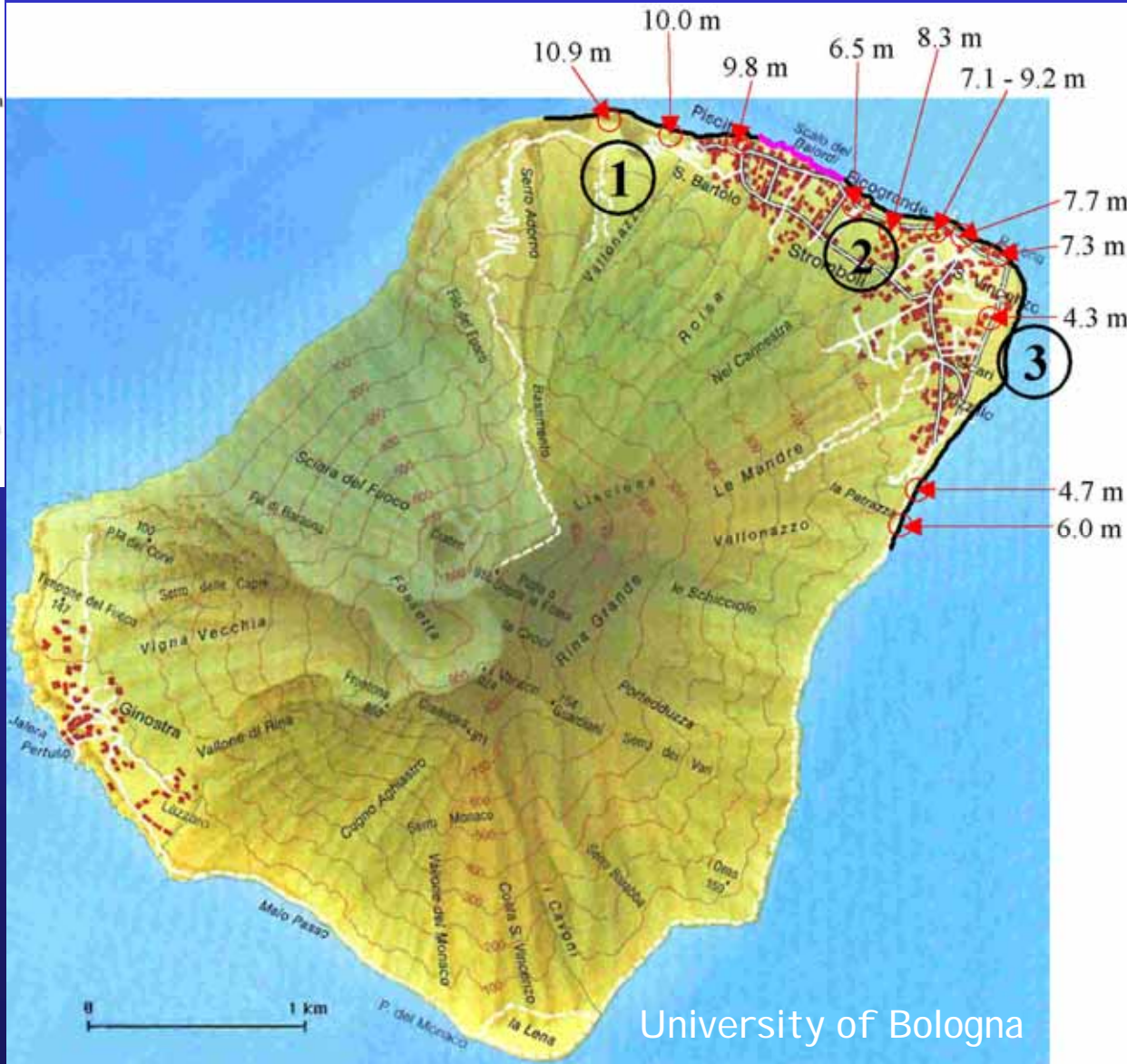
Costa settentrionale di Stromboli





Le onde di maremoto
in pochi minuti
raggiungono l'abitato di
Stromboli, causando
danni lungo la costa
settentrionale

Rilievi post-tsunami





LA RISPOSTA DI PROTEZIONE CIVILE

GESTIONE E SUPERAMENTO DELL'EMERGENZA:

COM DI LIPARI E COA DI STROMBOLI

INTERVENTI DI MITIGAZIONE DEL RISCHIO:

SENTIERI, SHELTER, NUOVO MOLO A GINOSTRA

SISTEMA DI ALLERTAMENTO:

COA DI STROMBOLI, CENTRI DI COMPETENZA,

CENTRO FUNZIONALE NAZIONALE

IL CENTRO OPERATIVO AVANZATO DI STROMBOLI

- 
- Monitoraggio del vulcano
 - Supporto logistico all'installazione di nuove reti di monitoraggio
 - Piano d'emergenza da rischio maremoto



PRESIDENZA DEL CONSIGLIO DEI MINISTRI
Dipartimento della Protezione Civile

"EMERGENZA STROMBOLI"

CENTRO OPERATIVO MISTO - LIPARI
CENTRO OPERATIVO AVANZATO - STROMBOLI

MAPPA DELLE RETI DI MONITORAGGIO

Aggiornamento al 29.03.2003

LEGENDA

- ⊕ Ondametri
- ⊙ Telecamere

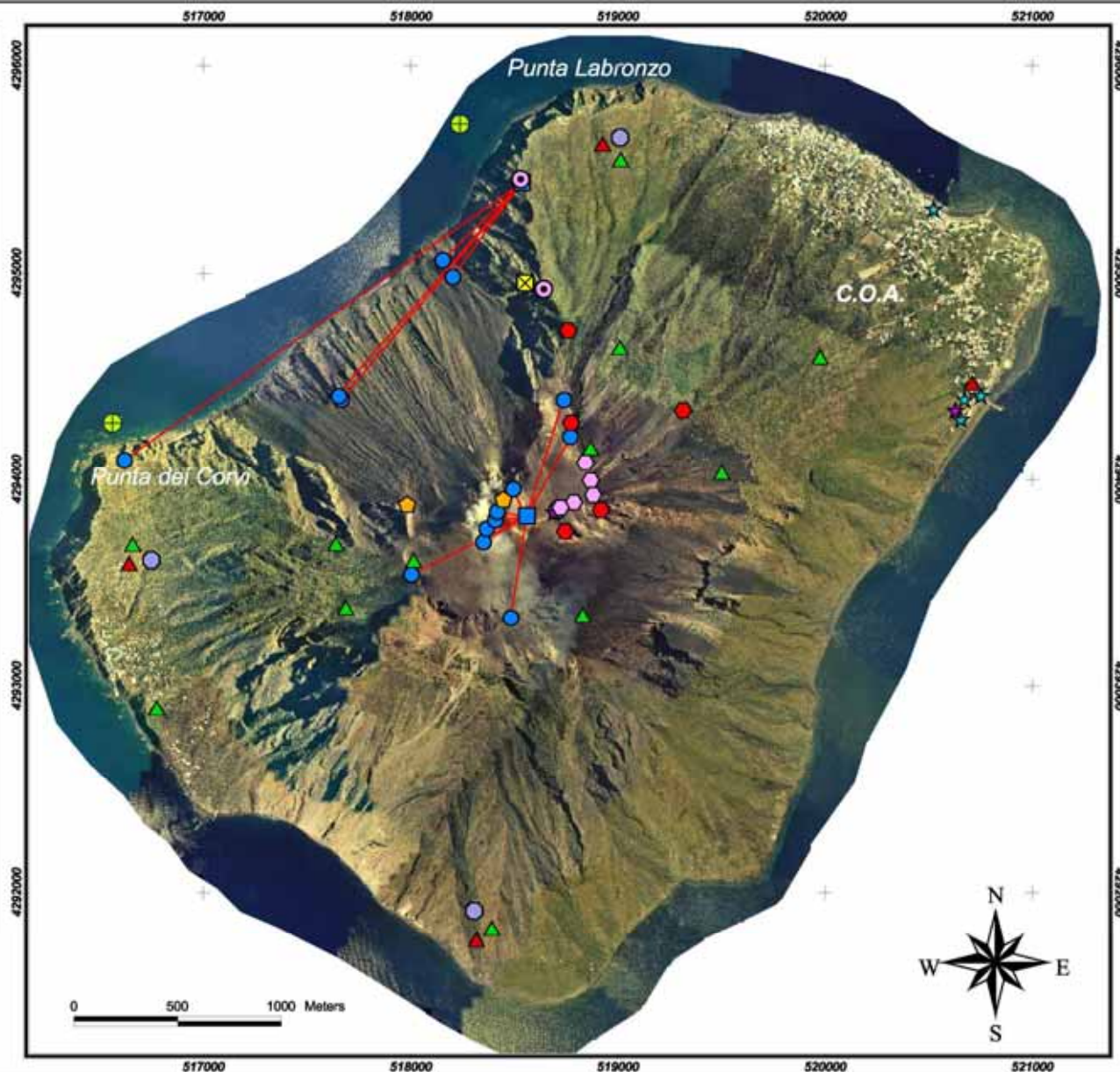
Rete sismica (Università di Firenze)

- Stazioni sismo-acustiche
- ⬡ Array infrasonico

Rete INGV

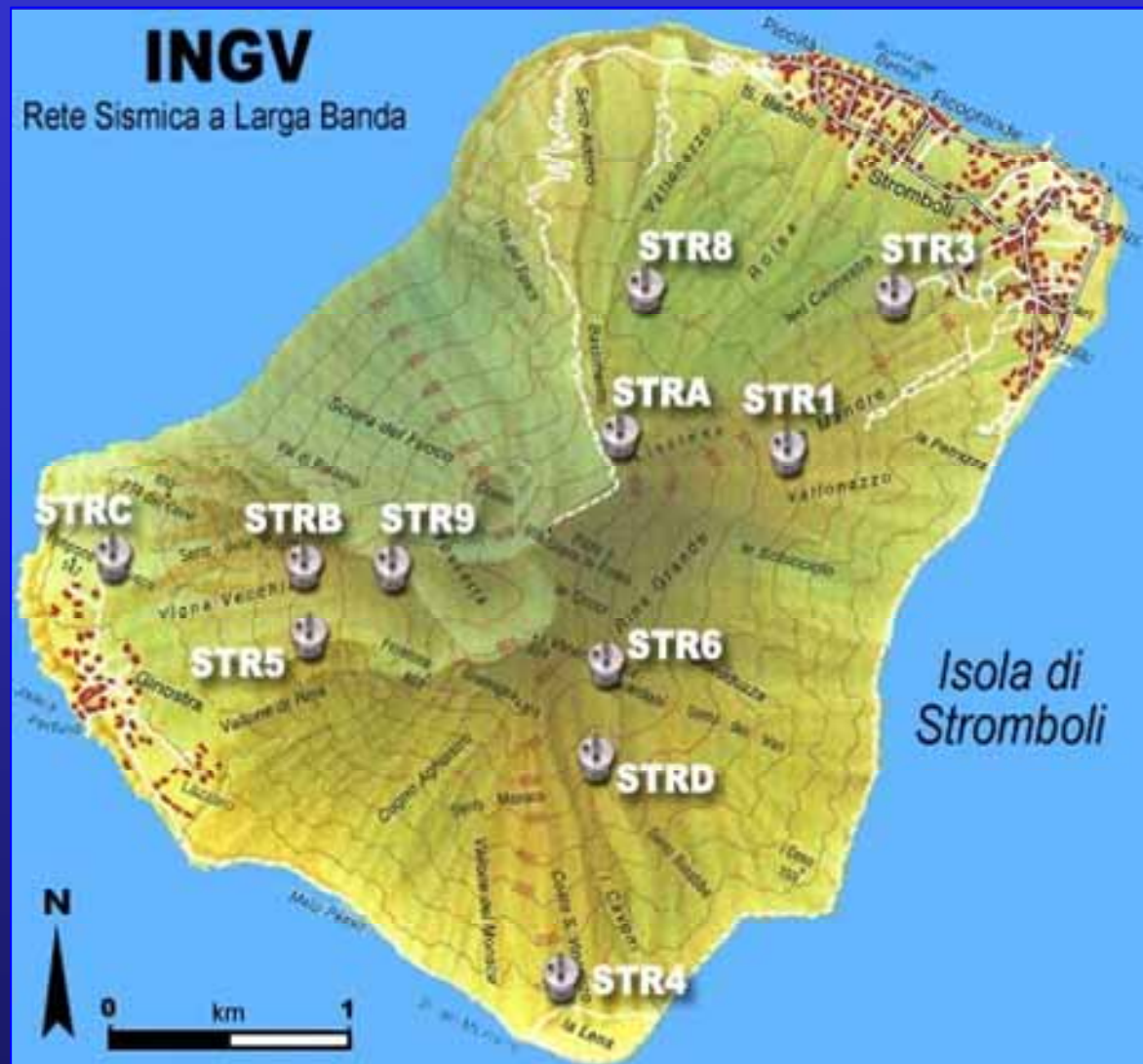
- ▲ Stazioni GPS permanenti
- Stazioni master EDM
- Capisaldi riflettenti EDM
- ★ Stazioni geochimica acque
- ★ Stazioni geochimica gas
- ▲ Stazioni sismiche
- ⊙ Telecamera
- ⊙ Stazioni clinometriche
- ⬡ Capisaldi geodetici GPS

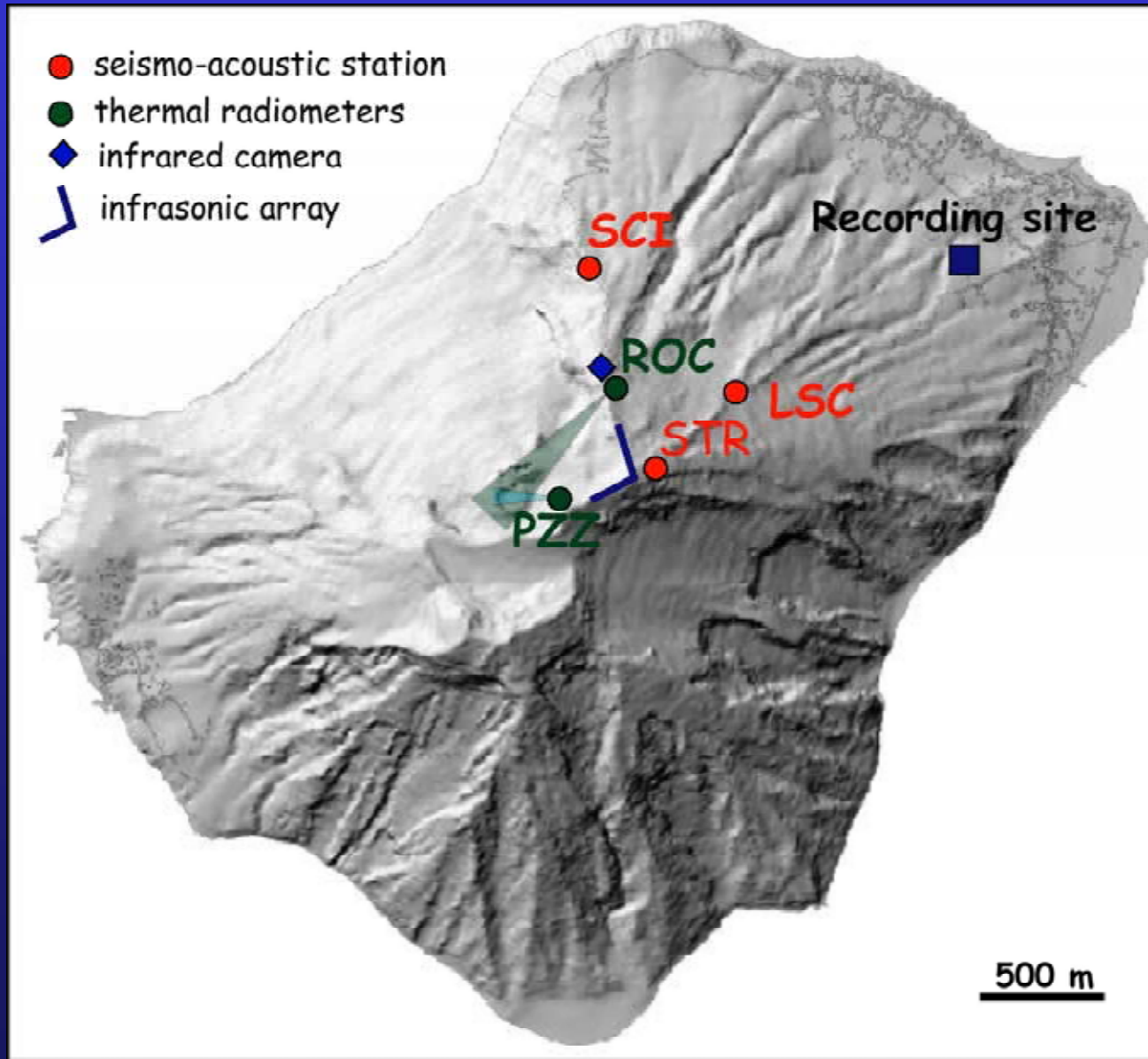
Immagine di base: Ortofoto ottenuta da da rilievo aerofotogrammetrico del maggio 2001 (Progetto GNV n.13)



Rete sismica

- Rete composta da 13 stazioni digitali con sensore a larga banda, a tre componenti.
- Trasmissione dei segnali in continuo, via radio-modem verso il COA e poi verso l'INGV (Catania, Napoli). Qui, personale di sorveglianza controlla H24



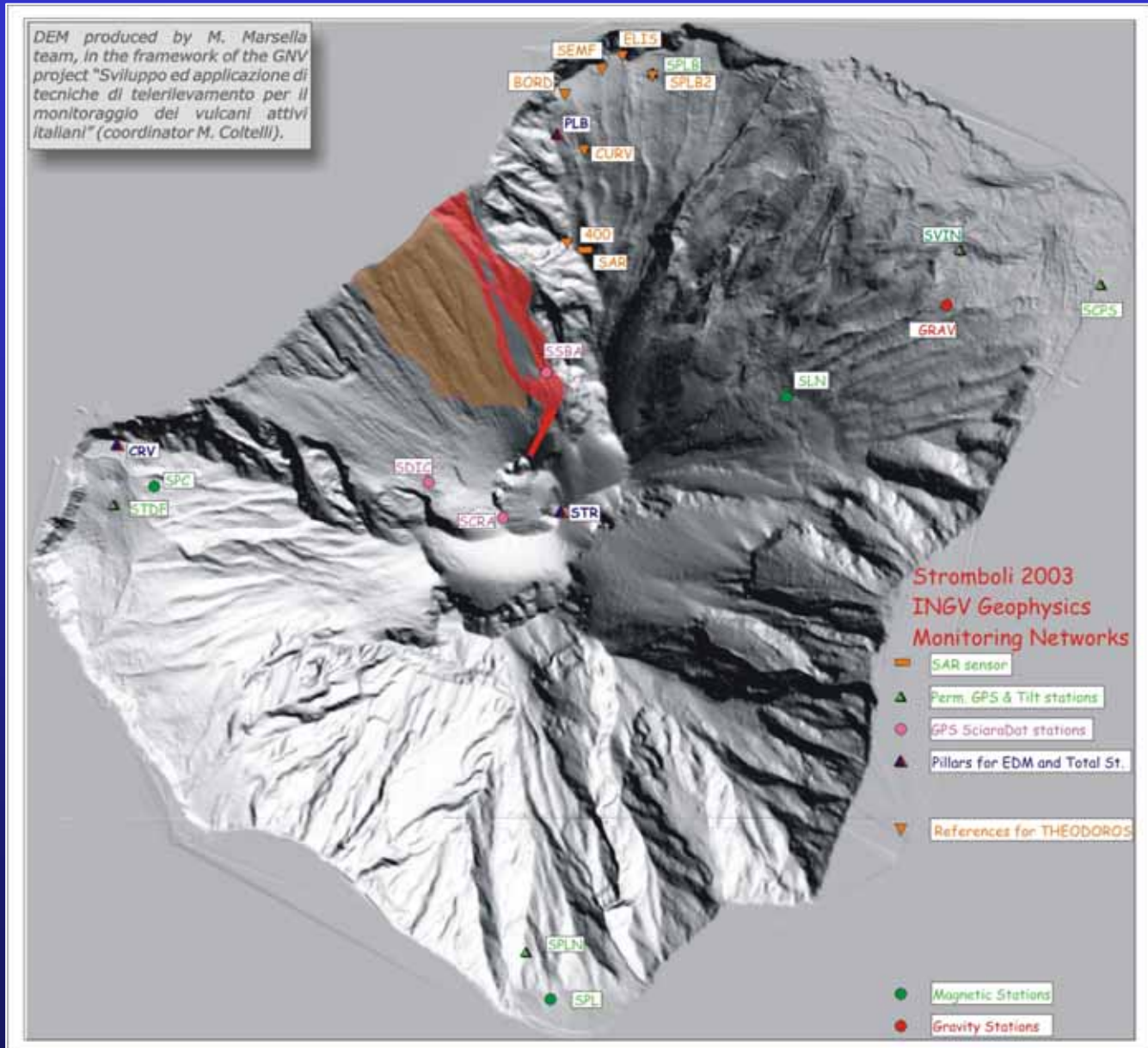


La rete sismo-acustica è composta da 5 stazioni posizionate in area craterica e sul versante nord del vulcano. Può registrare segnali sismici a larga banda, infrasonici e termici.

Monitoraggio geofisico

Per il controllo della Sciara del Fuoco sono stati installati vari sistemi di monitoraggio delle deformazioni del suolo che operano in maniera congiunta.

- Topografico (EDM e Stazione totale)
- GPS
- SAR



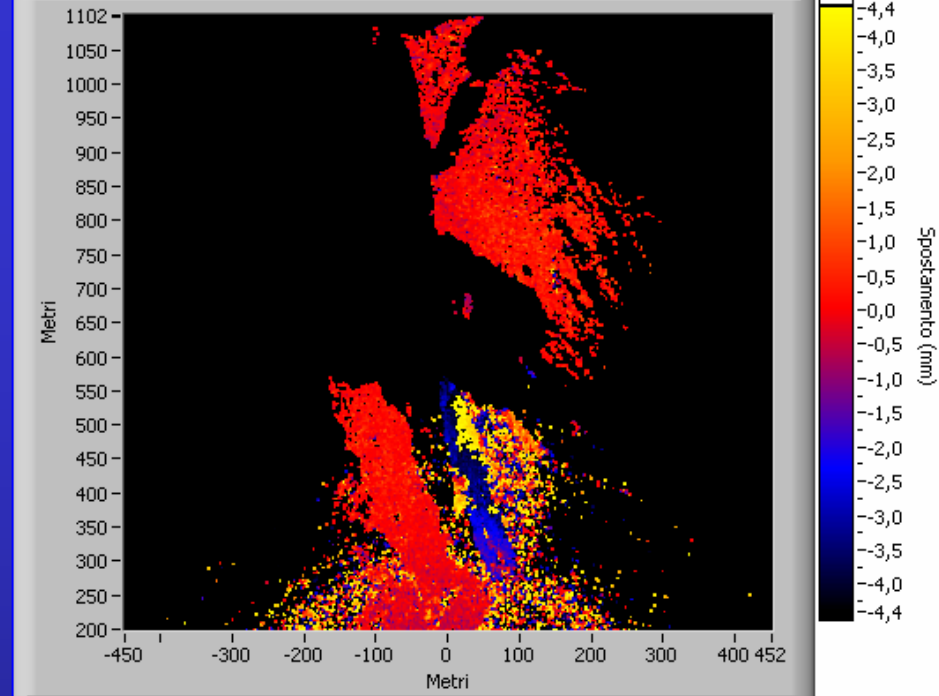
InGRID - LISA

*Interferometric Ground-based Imaging
Deformeter Linear Synthetic
Aperture Radar*





LiSA System



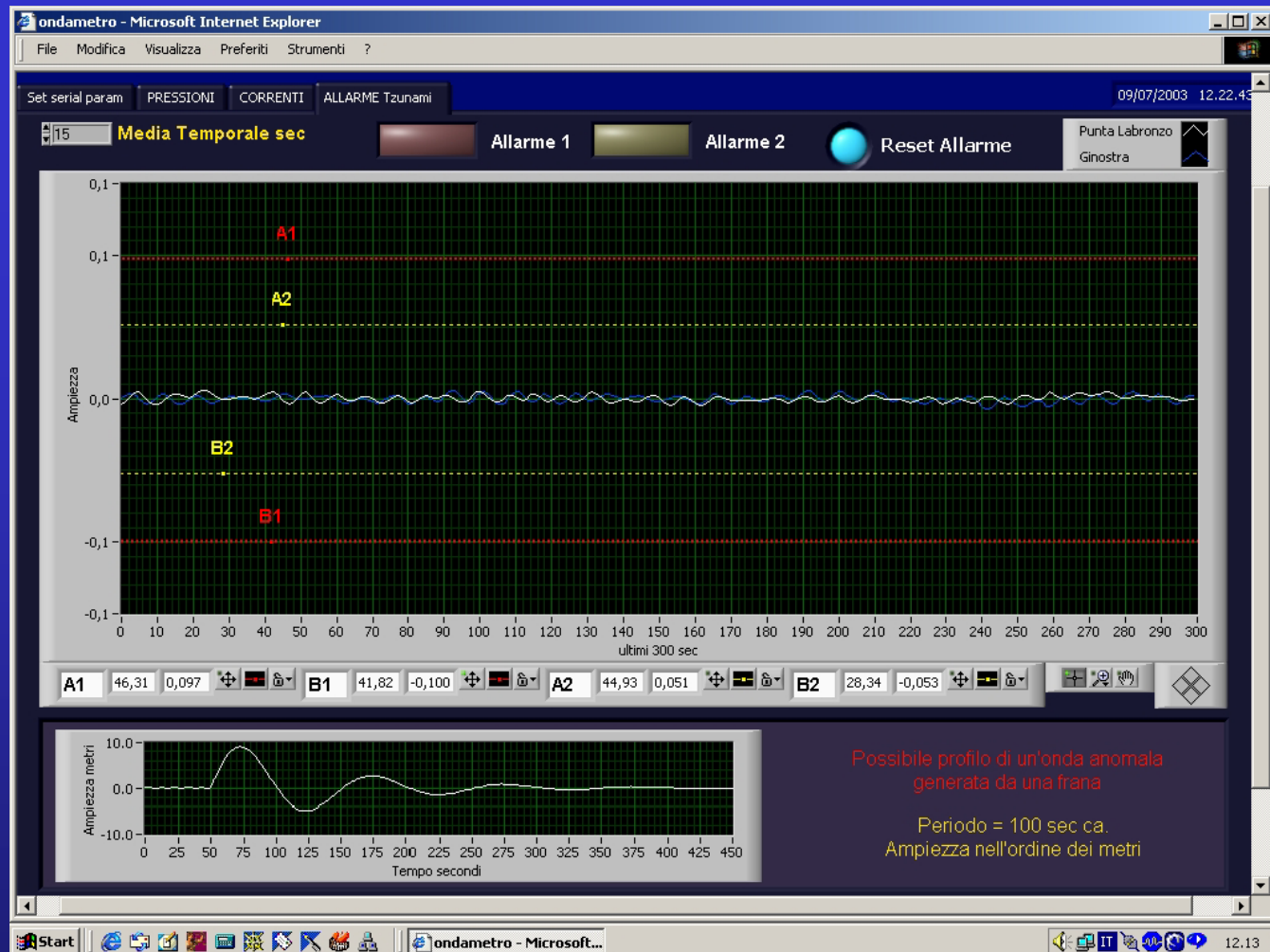
Il sistema radar InGrID-LiSA è un interferometro radar ad apertura sintetica, basato sulla tecnologia LiSA, messo a punto dell'Università di Firenze, dal Centro Comune di Ricerca (CCR) della Commissione Europea di Ispra e dalla LiSALab S.r.L.

Installato per la prima volta su un vulcano permette di ottenere informazioni su tutta l'area in esame, di giorno e di notte, anche con condizioni ambientali avverse (cenere, pulviscolo, nubi di gas).

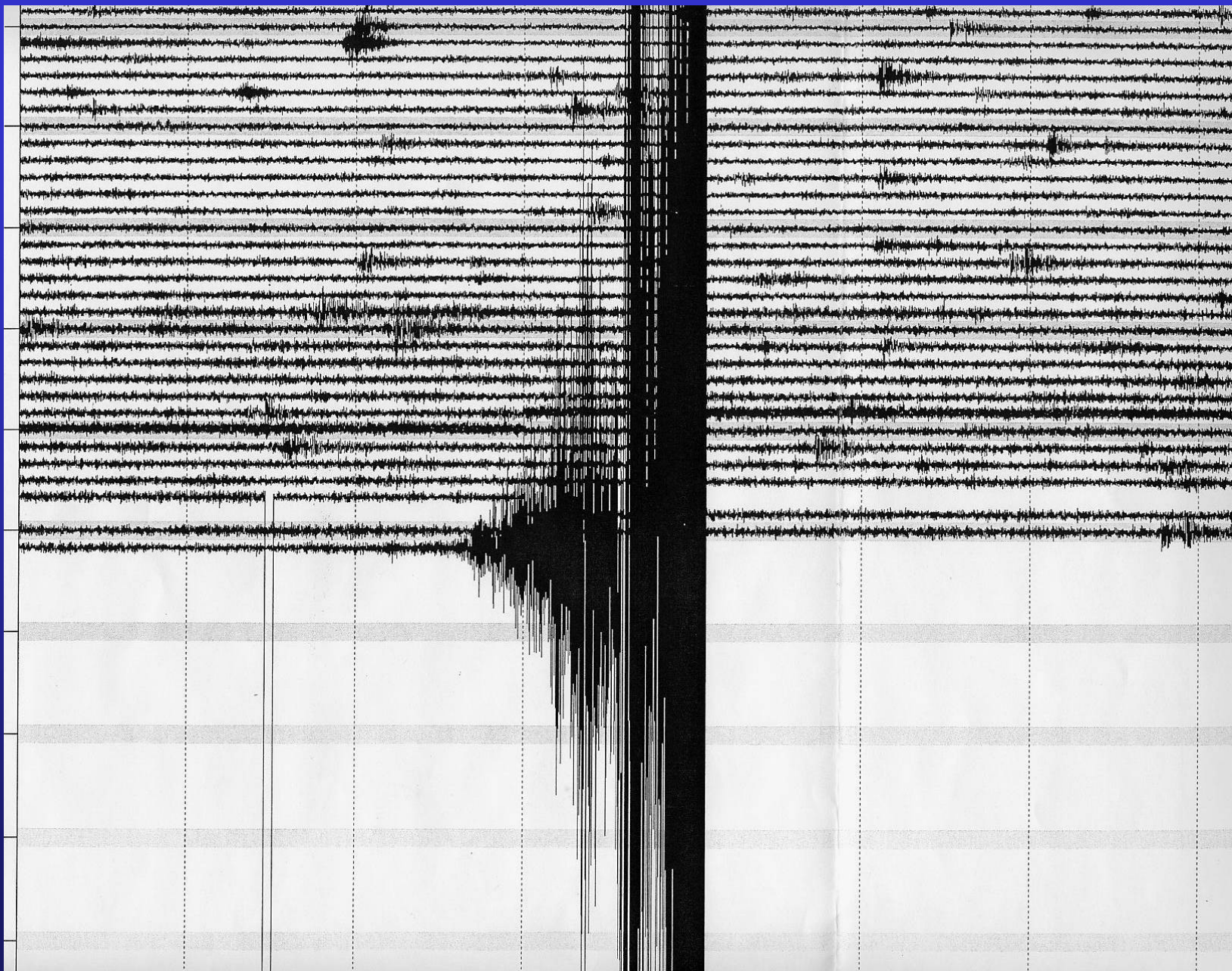
Il sistema è operativo dal febbraio 2003 ed acquisisce un'immagine della zona irradiata ogni 12 minuti.

Gli ondametri





Il software utilizzato per la visualizzazione in continuo dei dati degli ondametri. La finestra *Allarme Tsunami*, utilizzata per il monitoraggio in continuo e per l'allertamento rapido, riproduce l'andamento dei dati degli ultimi 5 minuti.



5 Aprile 2003, ore 9.12

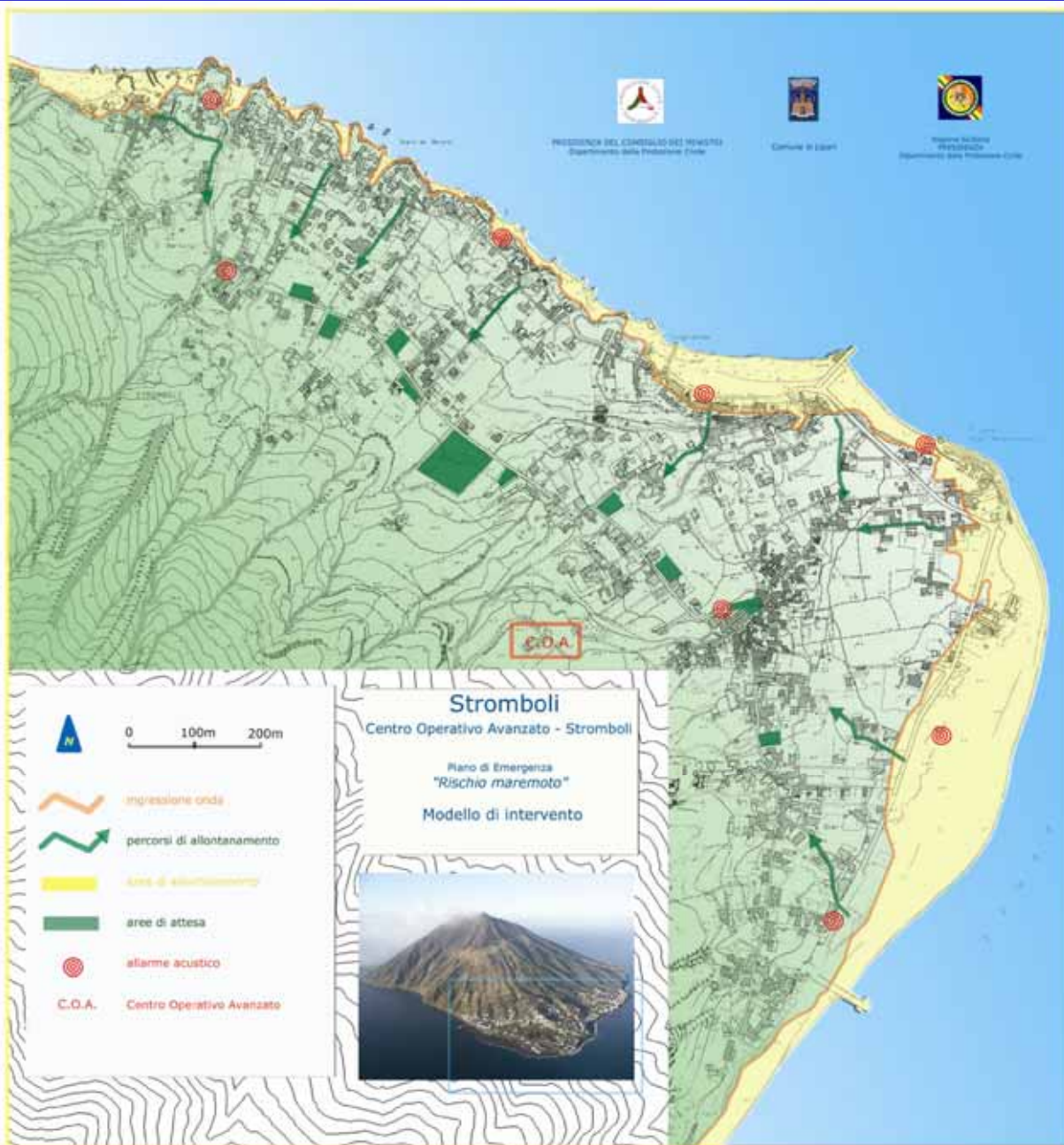


Foto A. Franssen

Piano d'emergenza da rischio maremoto: I fase



Piano d'emergenza da rischio maremoto



area di
allontanamento
temporaneo

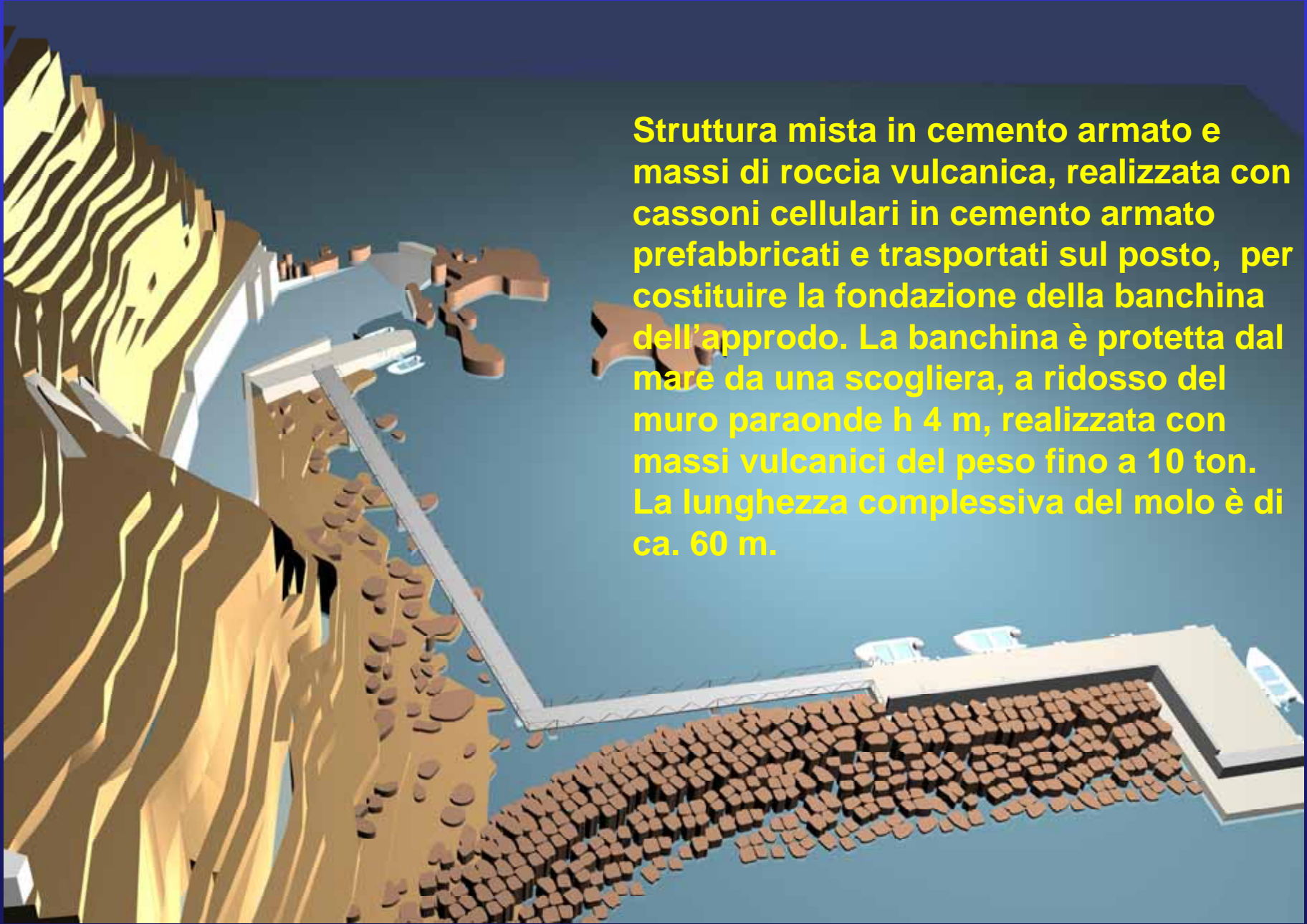
vie di fuga

aree di attesa

sirene

Il molo di Ginostra: il progetto

Struttura mista in cemento armato e massi di roccia vulcanica, realizzata con cassoni cellulari in cemento armato prefabbricati e trasportati sul posto, per costituire la fondazione della banchina dell'approdo. La banchina è protetta dal mare da una scogliera, a ridosso del muro paraonde h 4 m, realizzata con massi vulcanici del peso fino a 10 ton. La lunghezza complessiva del molo è di ca. 60 m.

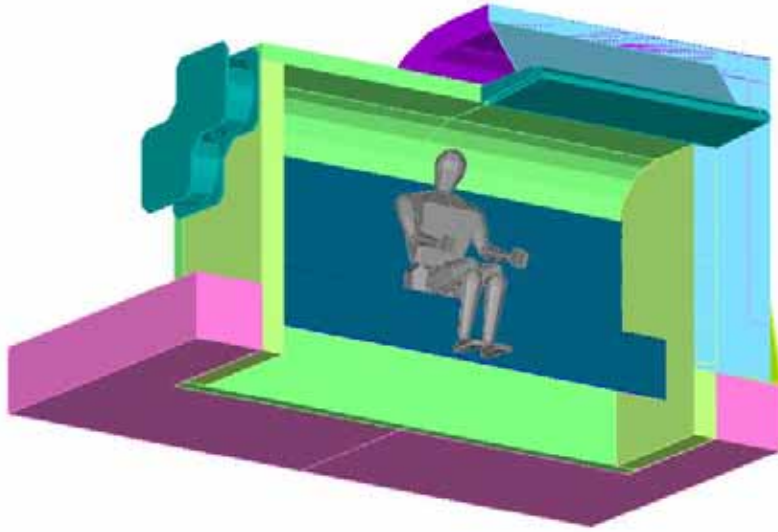


Il nuovo molo a Ginostra



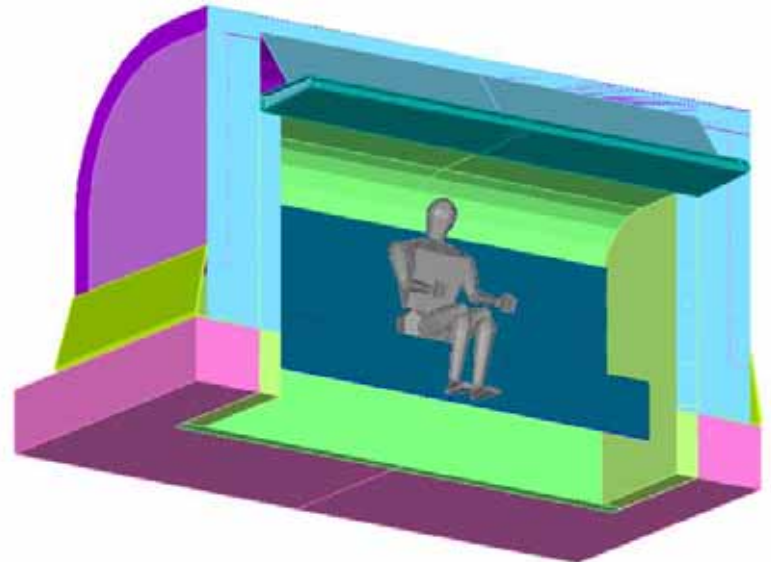
shelter

Università della Basilicata



La realizzazione di shelter di protezione per il personale scientifico e per gli escursionisti consentirà un'ulteriore diminuzione della esposizione, ma non potrà mai permettere l'annullamento del rischio.

Realizzati con tecniche di ingegneria antisismica (sistemi dissipativi).
Dimensioni ridotte e basso impatto ambientale.

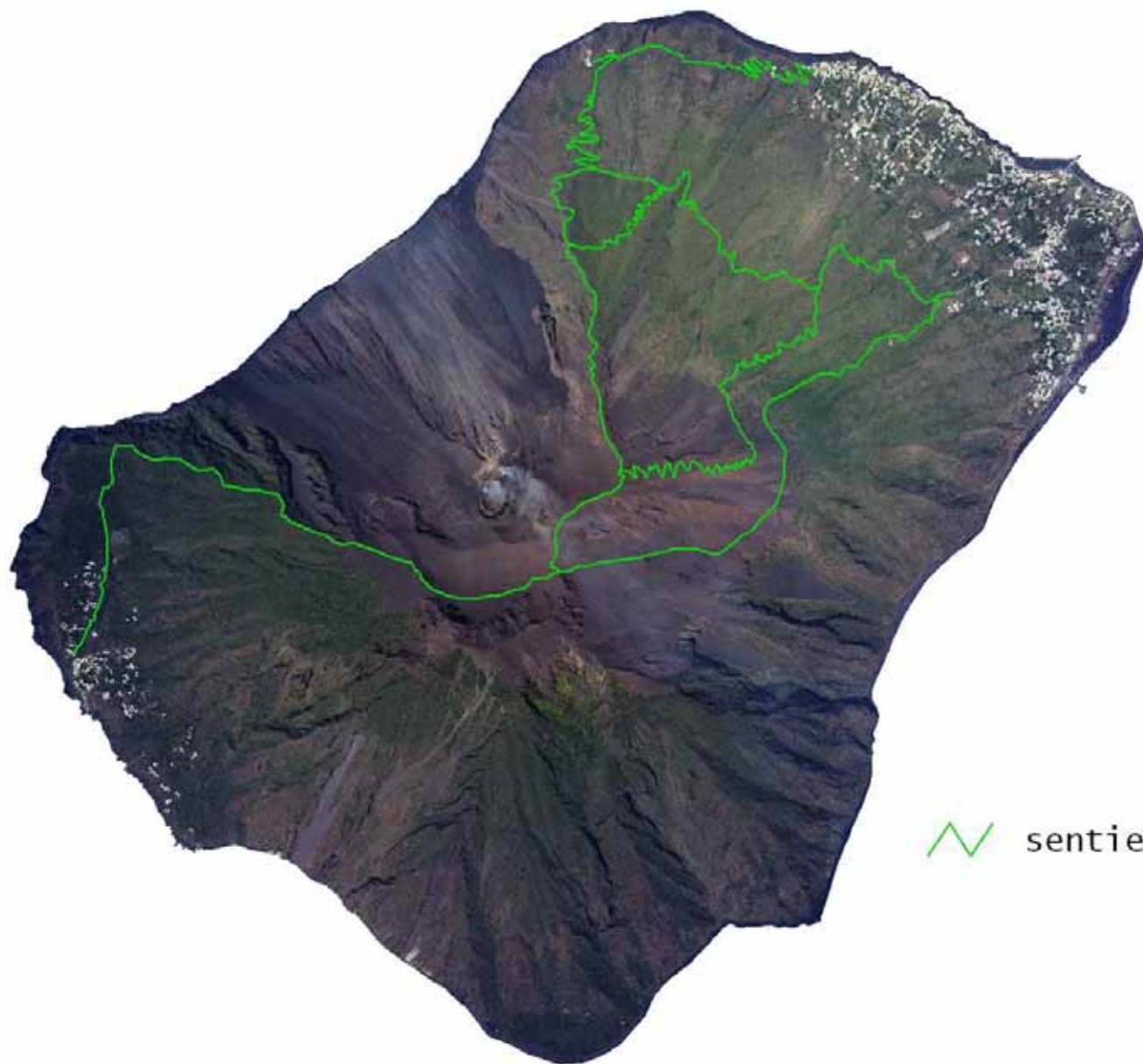


La struttura sarà in grado di resistere all'urto di un masso avente diametro di 0,50 m proveniente da una traiettoria di 400 m, in grado di assorbire l'energia d'urto mediante adeguati dispositivi dissipativi

Ogni shelter sarà in grado di proteggere circa 10 persone dalla caduta di massi. La struttura è in grado di resistere all'azione degli agenti atmosferici e chimici aggressivi (SO_2 , H_2S).



Prove dinamiche, settembre 2004



sentieri

I lavori sono stati eseguiti dall'Azienda regionale delle foreste demaniali della Regione Siciliana, sotto la supervisione diretta del DPC. Inoltre, essendo l'Isola di Stromboli riserva naturale, le opere sono state eseguite nel rispetto delle normative esistenti in materia di interventi in aree protette, secondo tecniche di ingegneria naturalistica.



Ordinanza sindacale
n.11/05 del 24 marzo
2005





© PIRELLA GÖTTSCHE LOWE, 2015. Stromboli (Stromboli) Ordinanza n. 11/05. Progetto G&P, 2015. B



STROMBOLI is an active volcano that reaches an altitude of over 3,040 feet. Following the trails that wind along its slopes, you can watch spectacular volcanic displays, immerse yourself in picturesque natural environments, and enjoy beautiful panoramic scenery.

This brochure gives you the information necessary to learn about the volcano and its risks, and enjoy this experience while respecting the environment.

The paragraphs about the rules for behavior on the island and the excursion activity contain particularly important practical information.



*Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile*



Comune di Lipari

Rules for Behavior

on the island of Stromboli

The Department of Civil Defense, in agreement with local Authorities, has set out a series of rules that provide the island's inhabitants and visitors with practical indications for behavior to follow in case of events that can be dangerous.

LANDSLIDES ALONG THE SCIARA DEL FUOCO.

The Sciara del Fuoco is the slope of the volcano where there are regular events in which boulders and stones roll down hill, and where larger landslides can also develop. For this reason, boating and swimming are prohibited within 440 yards of the coast in the entire area of the sea facing the Sciara del Fuoco.

PAROXYSMAL EXPLOSIONS.

Stromboli's paroxysms are accompanied by sharp and loud explosions similar to cannon shots, and by the formation of a large dark cloud.

These events do not last long (from a few seconds to minutes). Moving away from the area by running along the paths shifted by the volcano can provoke even greater damage. Most of the accidents in the past have taken place precisely due to people falling while fleeing hastily.

When these events – which can also cause fires in the vegetation – take place, it is thus appropriate to:

- if you are at the top of the volcano, take shelter immediately, if possible, in a covered place. If there is no shelter available, stay calm and follow the instructions of the guide;
- if you are in the area of Vallonazzo or of the Schicciolo, move away from the floor of the valley towards raised areas, due to the possible descent of landslides of hot material;
- if you are near the coast, move towards the inner part of the island, following the paths indicated by the relevant signs situated throughout the island;
- if you are at sea, move away from the island, out to sea.

TSUNAMIS

Stromboli's tsunamis are generally preceded by landslides from the Sciara del Fuoco or paroxysmal explosions. The danger of a tsunami being triggered leads to the implementation of procedures for alerting the population which may also include the activation of sirens installed in the inhabited areas of Stromboli and Ginostra. In any case, even if the alarm is not broadcasted, if you observe a paroxysmal explosion, a large landslide, or the withdrawal of the sea from the coast, you need to:

- immediately move away from the coastal area (out to sea if you are on a boat) following the paths indicated in the relevant signs situated throughout the island;
- reach the waiting areas.

The beach that goes from Piscità towards the Sciara del Fuoco only has tsunami escape paths on the first part of the beach, while the more western part lacks such paths, due to its natural configuration. This last part of the beach is also exposed to phenomenon of falling boulders.

EXCURSION ACTIVITY

Excursion activity is regulated according to criteria based on the level of danger of the volcano and respect for the environment. In order to satisfy heightened demand for being able to use the island's mountain environment, the

Department of Civil Defense and the State Forest Agency of the Sicily Region have organized a network of trails, adopting naturalistic engineering techniques and respecting the laws regarding interventions in protected areas. Access to the trails is free below 1,300 ft above sea level, and regulated at higher altitudes, where you must be accompanied by authorized volcanological guides.

The climb to the volcano is a mountain excursion that can be tiresome due to the steep slopes, the height of the climb and the heat, and thus it should be undertaken only by people in good physical condition. To go on such an excursion, you need to be equipped with adequate clothes and shoes, water and supplies. It is also important to never go off the trails and not to pick protected plant species.

EXCURSIONS ACCOMPANIED BY GUIDES

Based on the meteorological and volcano conditions, the guide makes the final decision as to undertaking the excursion. The guide can accompany individual or group excursions, that are in any case limited to a small number of people.

Before the beginning of the excursion, the guide supplies the COA and the Carabinieri Station in Stromboli with a list of people participating, the path to be taken, the time of departure and the expected time of return. The successful return from the excursion is also communicated.

CONTROLS

The personnel of the Financial Guard, the Carabinieri, the Forest Guards and the Local Police all have the task of carrying out controls along the volcano access paths and trails, in order to guarantee respect for the rules.

If single excursionists or groups of people take excursions above 1,300 ft without an authorized guide, they will be forced to turn back in order to complete the necessary procedures before beginning the excursion again.

CHANGES IN THE RULES

Should the volcanic conditions significantly change, the above mentioned rules may vary.

Such decisions will be communicated and publicized in the media, on the Department's web site www.protezionecivile.it and in the local area.

Informational notes valid since March 24, 2005 according to Municipal Ordinance n. 11/05.

TO KNOW MORE

Visitors who want to know more about what has been summarily presented here, can contact:

- the STROMBOLI COA
- the STROMBOLI INGV CENTER
- the offices of the ASSOCIATIONS OF STROMBOLI VOLCANOLOGY GUIDES

and can visit the web site www.protezionecivile.it

WELCOME TO THE MOST BEAUTIFUL ACTIVE VOLCANO IN THE WORLD

THE STROMBOLI VOLCANO

There is no show more fascinating than the one put on by an active volcano, a small point on the map where the earth lets us see what happens in the perennially burning-hot forge hidden in its depths. Each volcano has molded the landscape around it and modifies it continuously, sometimes with demonstrations of extraordinary power, and always with a continuous exchange between the power that emerges from the heart of the earth and the nature surrounding it.



The Aeolian Islands are an archipelago born of volcanic energy, which has made these parts of land set in the Mediterranean rise from the sea, and has never interrupted the dialogue with the nature around it, that has been in a continuous process of change for millennia. There are various indications of the volcanic nature of these islands, such as the gaseous emissions in Vulcano or near Panarea, but it is Stromboli above all that continues to offer mankind the grandiose spectacle of an active volcano.

Stromboli shows its vitality in a characteristic manner, with constant activity that is in fact called "Strombolian," characterized by the succession, at intervals of 10-20 minutes, of explosions that launch streaks



of incandescent lava, lapilli and ash into the air, up to a height of hundreds of yards. The explosions originate in mouths situated inside the three main craters, which are aligned with one other, at an altitude of about 2,300 feet in the high part of the Sciara del Fuoco.



Besides the explosive activity which we can define as "ordinary," the craters are periodically affected by other types of explosions: "major" explosions and "paroxysmal" explosions. Major explosions take place an average of twice a year, causing the fall of heavy materials (blocks of rocks and volcanic bombs) on the higher part of the mountain. "Paroxysmal" explosions, on the other hand, have a cycle of several decades, and can launch heavy materials at greater distance, down to lower altitudes. Periodically, every 10 to 20 years, the volcano pours lava flows into the Sciara del Fuoco.

The eruptive phenomena of the volcano can destabilize the slope of the Sciara del Fuoco, provoking landslides that involve the parts of the structure both above and below the sea level. The landslides, depending on their volume, can trigger tsunamis with effects along the coast of Stromboli itself, Panarea, and even the other Aeolian Islands, and Calabria and Sicily. There have been five tsunamis in the past 100 years: in 1916, 1919, 1930, 1944, and most recently, in 2002.

VISITING AN ACTIVE VOLCANO

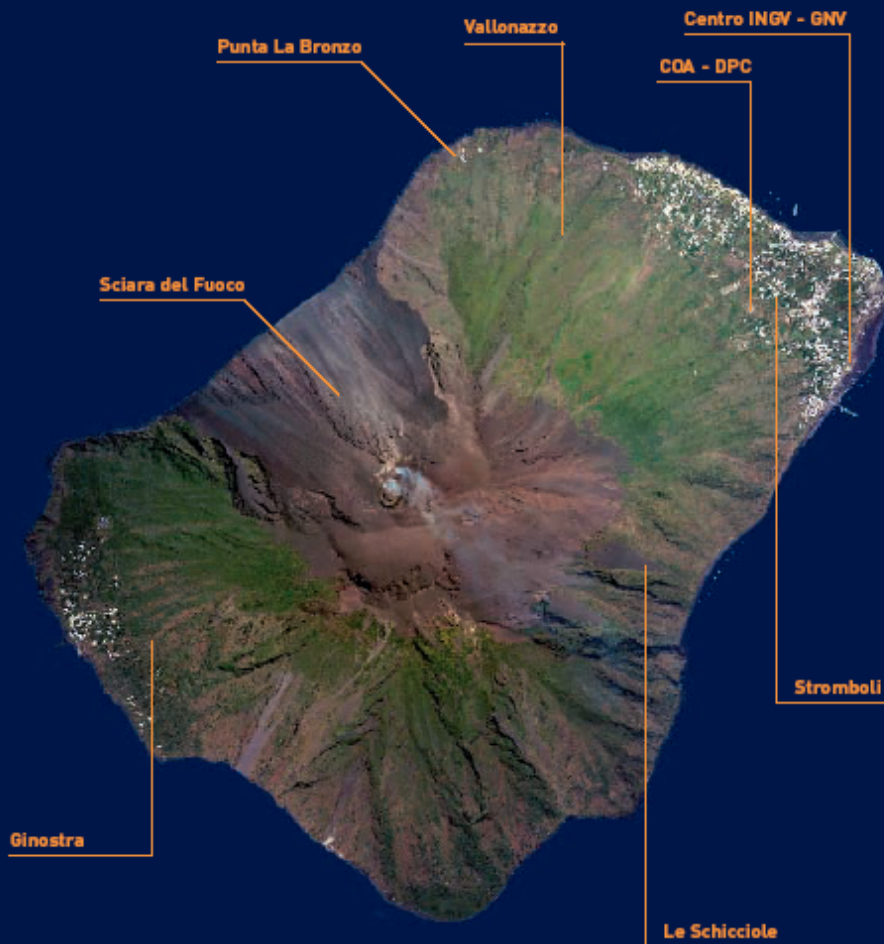
A volcano is not a calm and completely stable corner of the earth, but rather a permanent workshop of nature, where the "work" is always going on and

exceptional events can take place at any time.

Visitors to the island should be conscious of this situation, and be informed about the main phenomena that can occur at Stromboli, and the rules of behavior to be followed when the volcano makes its vitality felt in a more impulsive than normal manner.

The 2002 tsunami and the paroxysmal explosion in 2003 reminded everyone that the volcano, although usually "mild," can be dangerous at times. For this reason, in recent years the Civil Defense has built and maintained a 24-hour monitoring system that continuously analyzes the behavior of the volcano, to detect any possible signs of variation in its condition, utilizing cutting edge technological and scientific instruments.

The C.O.A. - Advanced Operational Center - of the Civil Defense, which is active throughout the year, is the local terminal of a series of monitoring networks managed by the National Institute of Geophysics and Volcanology (INGV), and by the University of Florence. You can visit the C.O.A. to get a clear idea of the national community's strong commitment to constantly watching over the volcano and being able to intervene immediately, if necessary, to bring the island's inhabitants and visitors to safety. Currently, the monitoring networks make it possible to reduce the likelihood that the danger of the volcano causes damage to people. However, although this is possible for the landslides along the Sciara del Fuoco, it may not be so for the major explosions and the paroxysmal explosions. In fact, the customary persistent activity of the volcano puts it in a constant state of "ordinary criticality," such that explosive phenomena that involve areas outside of the craters are always possible, and in the current state, unpredictable.



USEFUL NUMBERS

ADVANCED OPERATIONAL CENTER (COA)
DEPARTMENT OF CIVIL PROTECTION
090 986183

LIPARI MUNICIPALITY, STROMBOLI DELEGATION
090 9865730

INGV-GNV CENTER
090 986708

CALABRICHIO
090 986021

MEDICAL GUARD STROMBOLI
090 986097

MEDICAL GUARD GINOSTRA
090 9812822

PHARMACY STROMBOLI
090 986713

AGUILONE AGAI GUIDE
090 986211

MAGNATICK GUIDE
090 9865768

ZERELLI AGAI GUIDE
090 986263



Eolie - Stromboli island

Centro Funzionale Nazionale



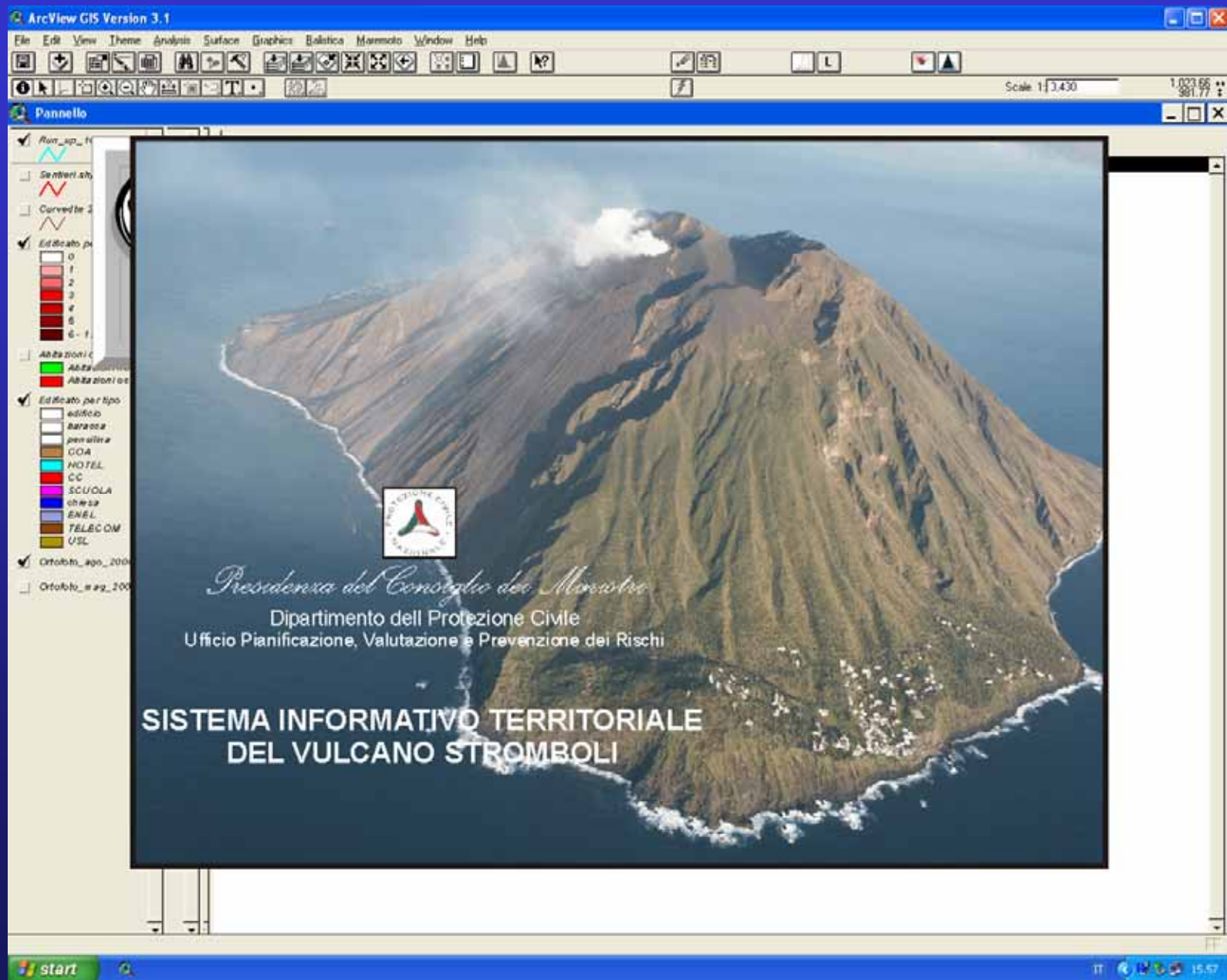
Centri di Competenza

INGV, Università di Firenze-DST, ...



Centro Operativo Avanzato di Stromboli

Centro Funzionale Nazionale



Esercitazione Stromboli 19 aprile 2005

tre scenari di evento

ai quali corrispondono stati di allertamento e
conseguenti fasi operative

SCENARIO 1

Aumento attività esplosiva del vulcano e rientro
nell'attività ordinaria

SCENARIO 2

Forte e improvvisa esplosione provoca il ferimento di escursionisti

SCENARIO 3

Attività effusiva lungo la Sciara del Fuoco.

Evento di frana e innesco di maremoto



Dipartimento della Protezione Civile
CENTRO FUNZIONALE NAZIONALE




ESERCITAZIONE 19 APRILE 2005

**MODELLO di SIMULAZIONE
delle ESPLOSIONI**

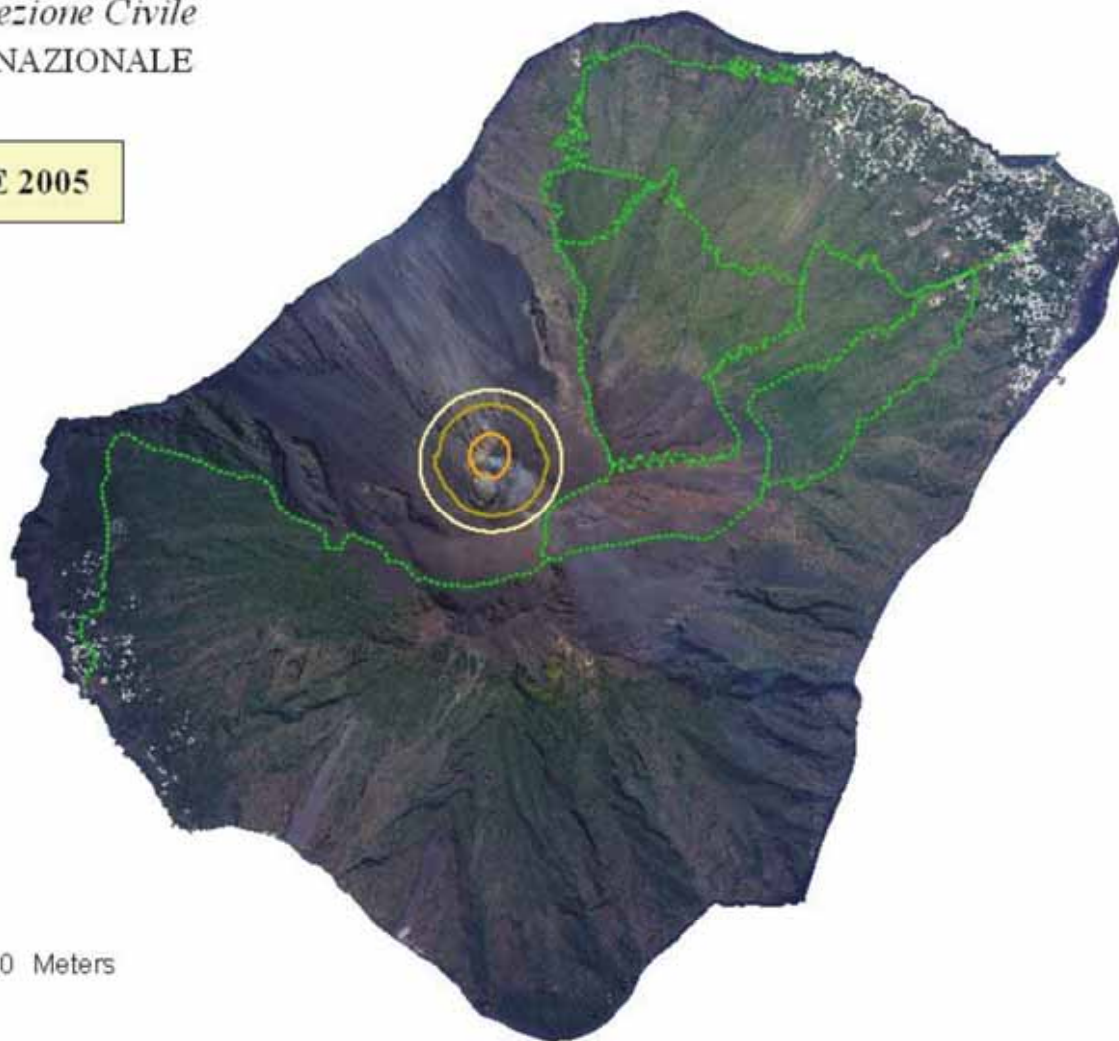
PARAMETRI di INPUT della
SIMULAZIONE:

- pressione infrasonica 2.6 bar
- cratere NE (Stromboli)

Dimensione massima
dei blocchi di ricaduta

-  5 - 10 cm
-  2 - 5 cm
-  1 - 2 cm

0 1000 2000 Meters



Dipartimento della Protezione Civile
CENTRO FUNZIONALE NAZIONALE

ESERCITAZIONE 19 APRILE 2005

**MODELLO di SIMULAZIONE
delle ESPLOSIONI**

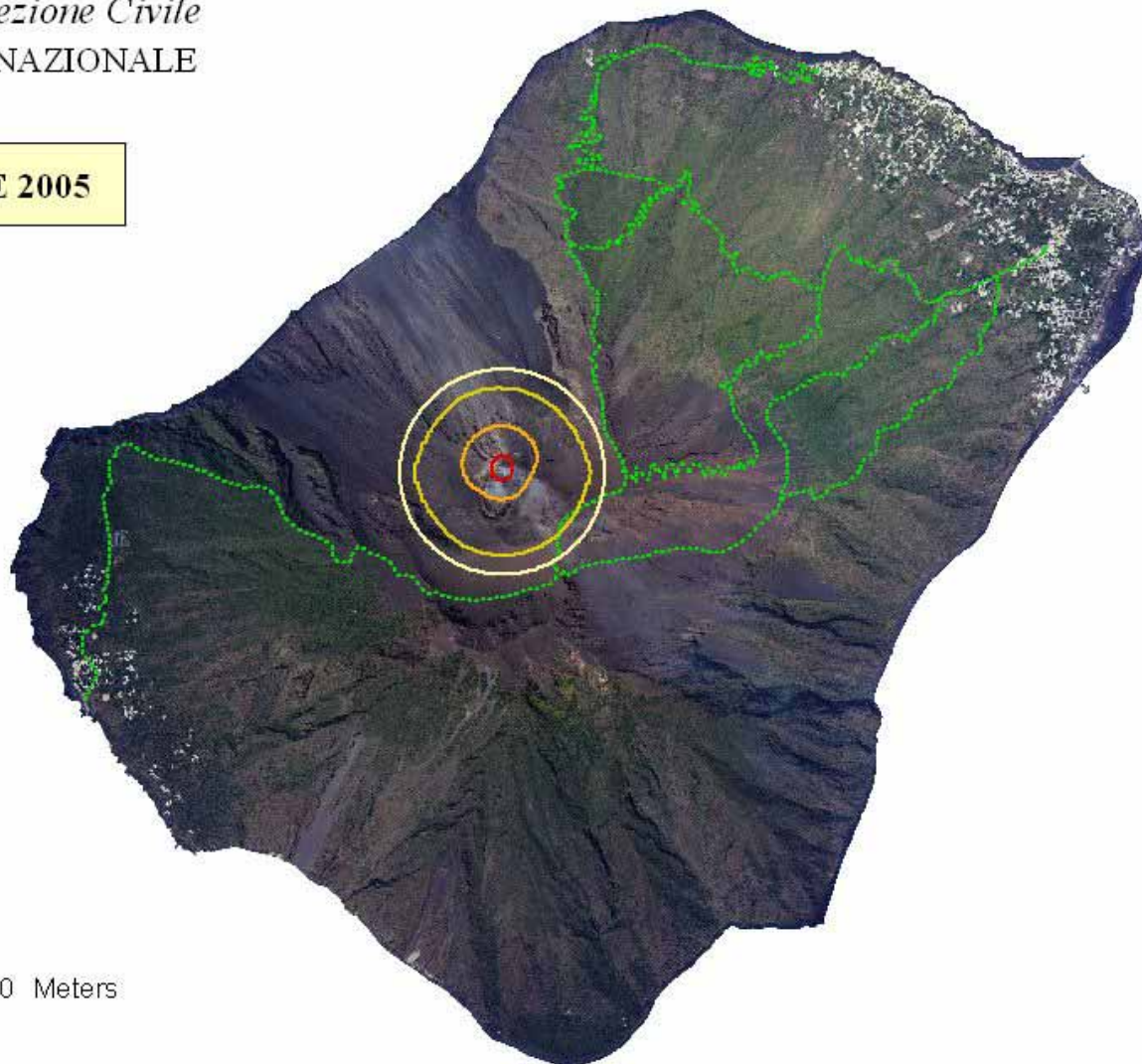
PARAMETRI di INPUT della
SIMULAZIONE:

- pressione infrasonica 3.1 bar
- cratere NE (Stromboli)

Dimensione massima
dei blocchi di ricaduta

- 10 - 20 cm
- 5 - 10 cm
- 2 - 5 cm
- 1 - 2 cm

0 1000 2000 Meters


ESERCITAZIONE 19 APRILE 2005


**MODELLO di SIMULAZIONE
delle ESPLOSIONI**

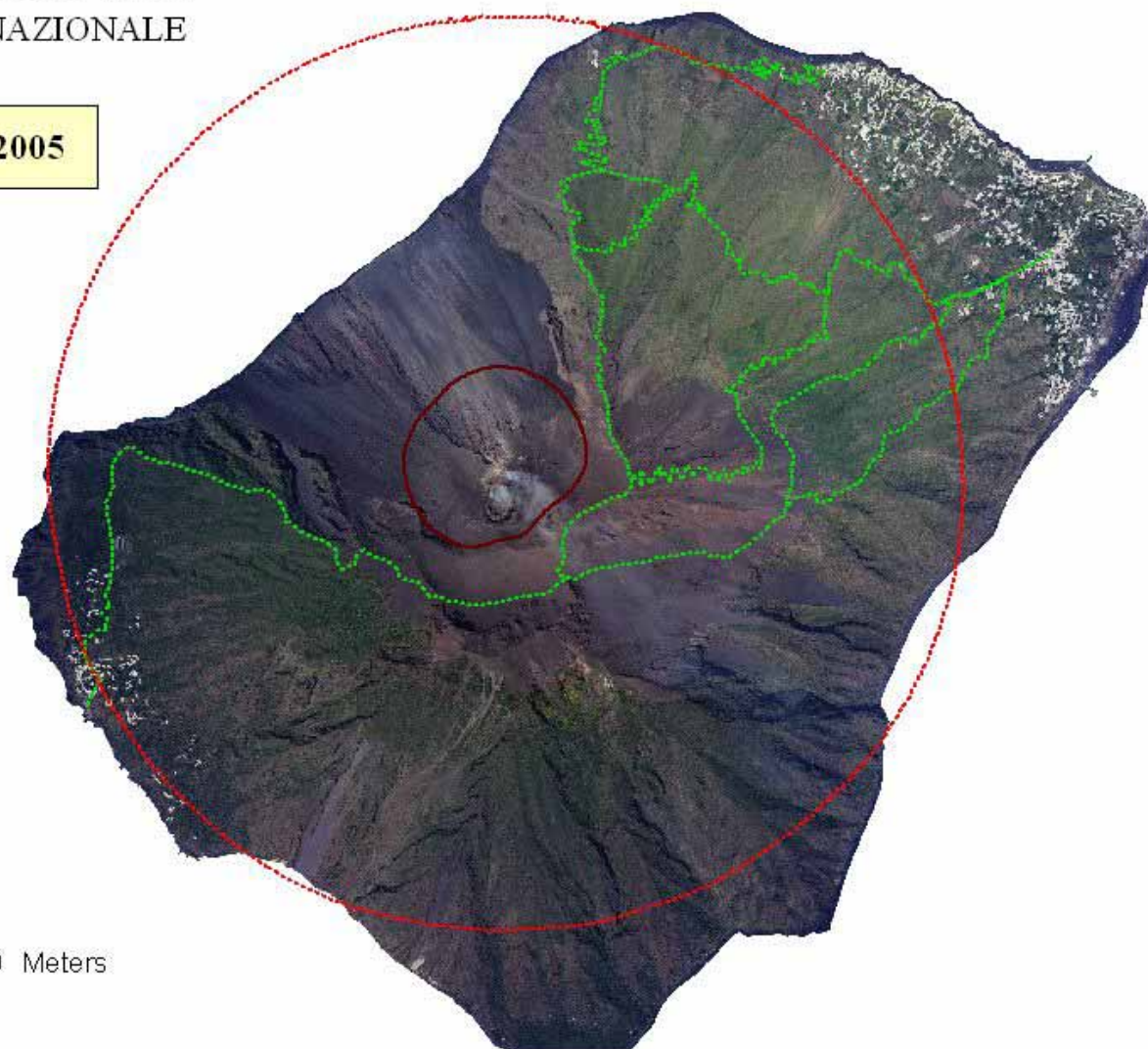
**PARAMETRI di INPUT della
SIMULAZIONE:**

- pressione infrasonica 25 bar
- cratere NE (Stromboli)

Dimensione massima
dei blocchi di ricaduta

 2 - 3 m

 1 - 2 m



0 1000 2000 Meters





Dipartimento della Protezione Civile
CENTRO FUNZIONALE NAZIONALE

ESERCITAZIONE 19 APRILE 2005

MODELLO di SIMULAZIONE delle ESPLOSIONI

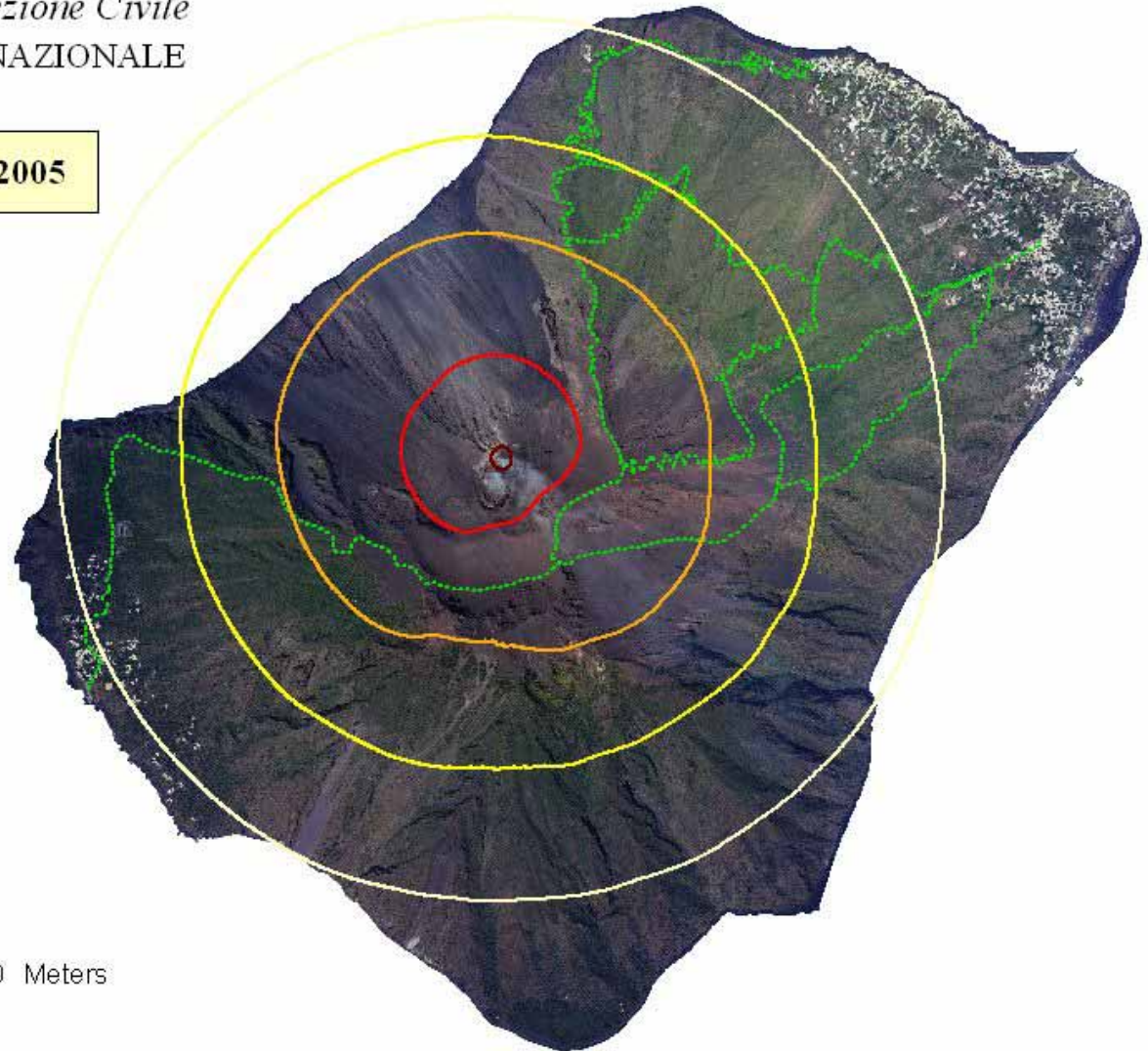
PARAMETRI di INPUT della SIMULAZIONE:

- pressione infrasonica 20 bar
- cratere NE (Stromboli)

Dimensione massima dei blocchi di ricaduta

- 2 - 3 m
- 1.4 - 2 m
- 1 - 1.4 m
- 0.8 - 1 m
- 0.6 - 0.8 m

0 1000 2000 Meters





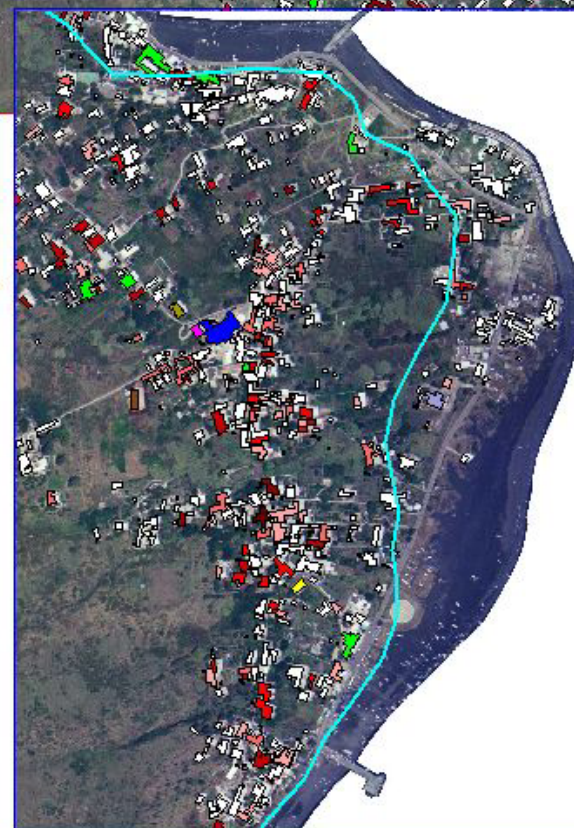
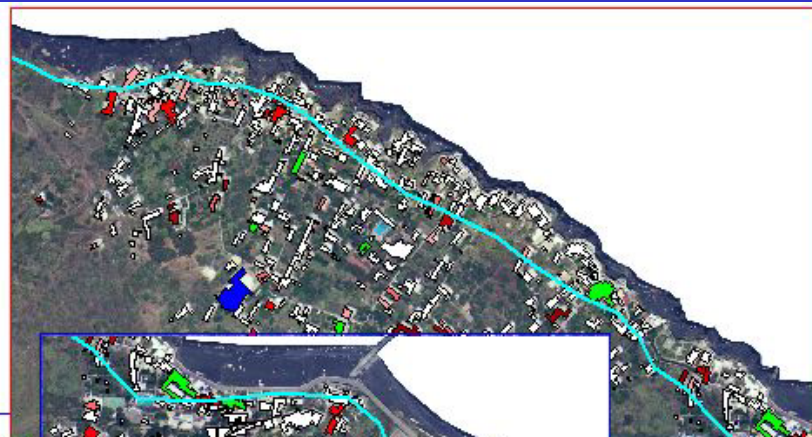
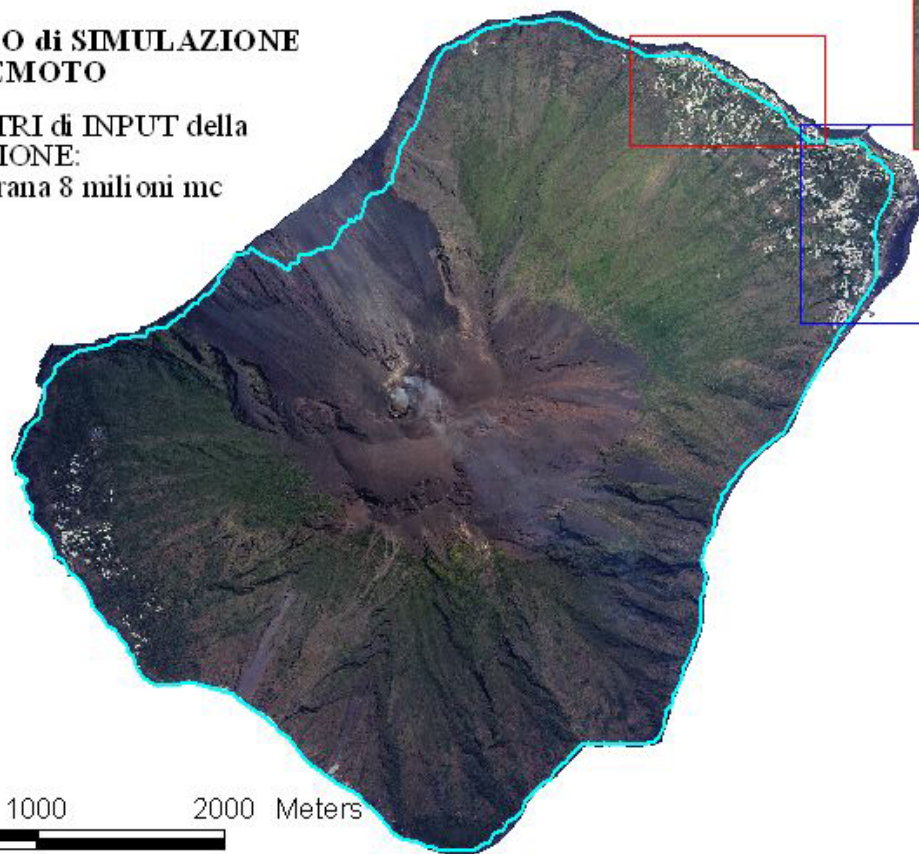
Dipartimento della Protezione Civile
CENTRO FUNZIONALE NAZIONALE

ESERCITAZIONE 19 APRILE 2005

MODELLO di SIMULAZIONE del MAREMOTO

PARAMETRI di INPUT della
SIMULAZIONE:

- volume frana 8 milioni mc



Edifici pubblici
per tipologia

- HOTEL
- CC
- SCUOLA
- CHIESA
- ENEL
- TELECOM
- USL

Edifici privati per
n. di residenti

- 0
- 1
- 2
- 3
- 4
- 5
- 6 - 12

~ Massimo
run-up

0 1000 2000 Meters



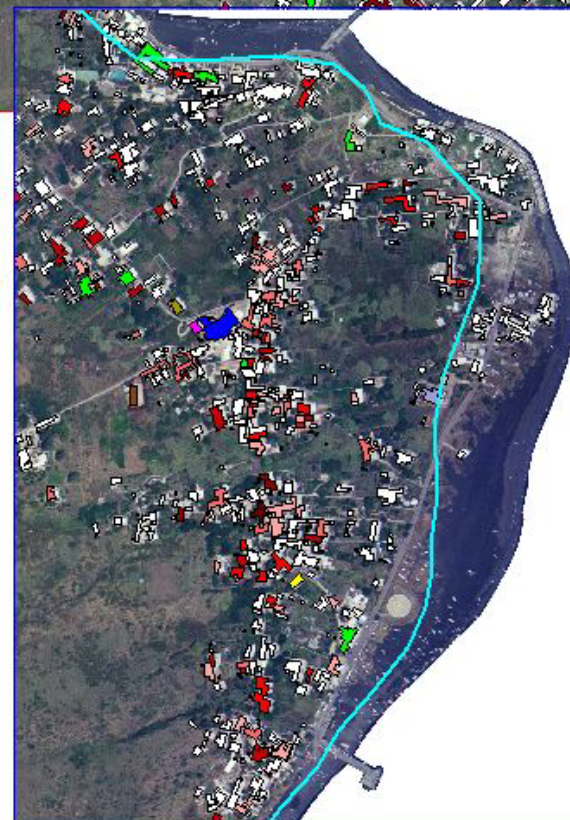
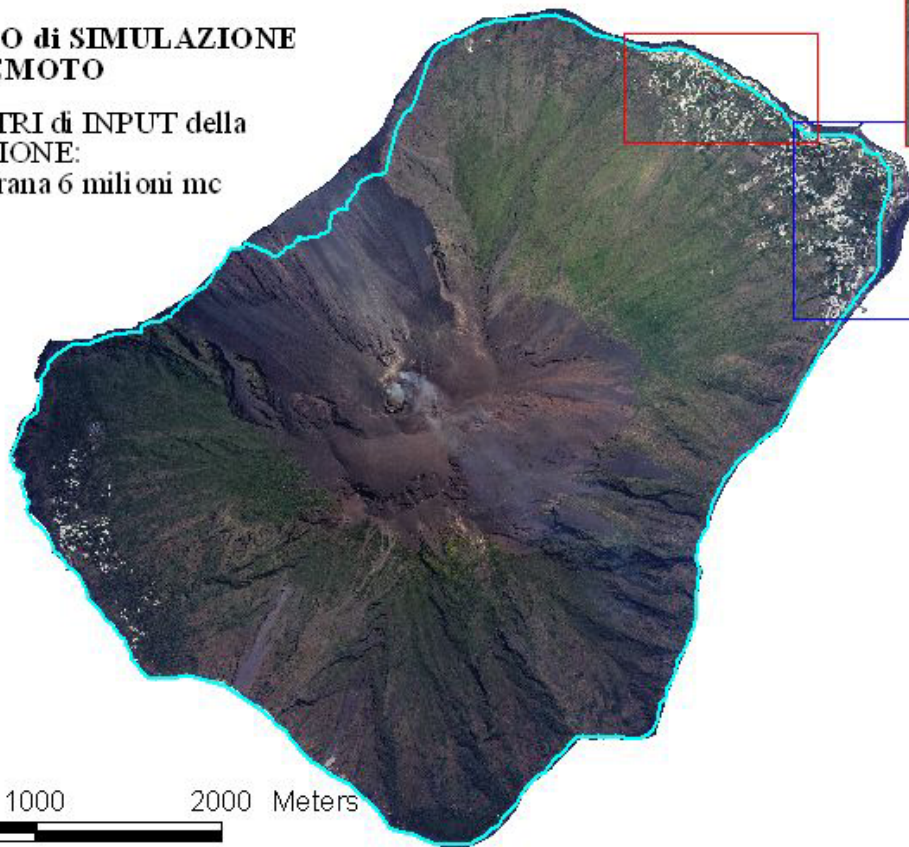
Dipartimento della Protezione Civile
CENTRO FUNZIONALE NAZIONALE

ESERCITAZIONE 19 APRILE 2005

MODELLO di SIMULAZIONE del MAREMOTO

PARAMETRI di INPUT della
SIMULAZIONE:

- volume frana 6 milioni mc



Edifici pubblici
per tipologia

- HOTEL
- CC
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Edifici privati per
n. di residenti

- 0
- 1
- 2
- 3
- 4
- 5
- 6 - 12

~ Massimo
run-up

