

# Integrated risk assessment methodologies in areas with high concentration of industrial facilities

Tools and approaches to analyze integrated risk between multiple nearby plants in the P. Gargallo – Melilli - Augusta industrial area (SR)

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# Priolo-Melilli-Augusta Industrial HUB



## Priolo–Augusta–Melilli HUB:

- One of the largest petrochemical hub in Europe (21 Km)
- History of accidents and environmental crises
- Need for coordinated risk assessment at territorial scale

## Scope of the evaluation

- Human safety (individual & societal risk)
- Infrastructure vulnerability (roads, railways, pipelines)
- Environmental targets (air, soil, groundwater, protected areas)

# Priolo-Melilli-Augusta Industrial HUB



## Industrial plants:

Maxcom;

Sasol;

Refinery ESSO, (now Sonatrach Italia)

Refinery ISAB S.r.l. impianti Nord;

Polimeri Europa;

Syndial;

ENIMED;

Air Liquide;

Refinery ISAB S.r.l. impianti Sud;

ERG Nu.Ce.;

ISAB Energy.

# Mandate and Membership of the IASS Evaluation Public Commition

**Ministry of the Environment (MATTM) required Integrated Area Safety Study (IASS) based on Ravenna & Livorno case experience. Study commissioned to operators (2001–2003), reviewed by Commission (2005–2008) whose membership were:**

## National Authorities:

- MASE - Ministry of the Environment & Energy Security (formerly MATTM)
- ISPRA - National Institute for Environmental Protection and Researchs (formerly APAT)
- National Fire Brigades (CNVVF)
- Istituto Superiore di Sanità, INAIL, CNR

## Regional & Local Bodies

- ARPA Regione Siciliana, Prefecture of Siracusa
- A Sicilia (Sicily Environmental Protection Agency)
- CTR Sicilia (Regional Technical Committee)
- Municipalities: Priolo, Augusta, Melilli, Siracusa

## Other stakeholders

- Harbour Authorities (Augusta, Siracusa)
- Industrial operators & Confindustria Siracusa
- Trade associations, civil protection actors

# Goals of the integrated risk analysis study (IAAS)

## General Goals

- Provide comprehensive cumulative risk assessment
- Support national and regional decision-making

## Specific Objectives

- Identify critical risk sources and domino effects
- Assess compatibility of industrial sites with urban development
- Improve emergency preparedness and response capacity.

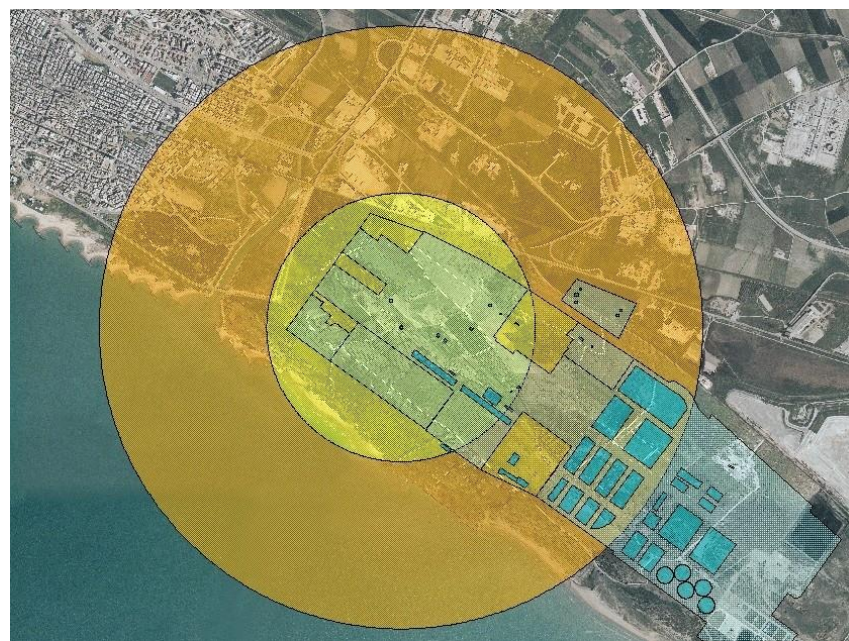
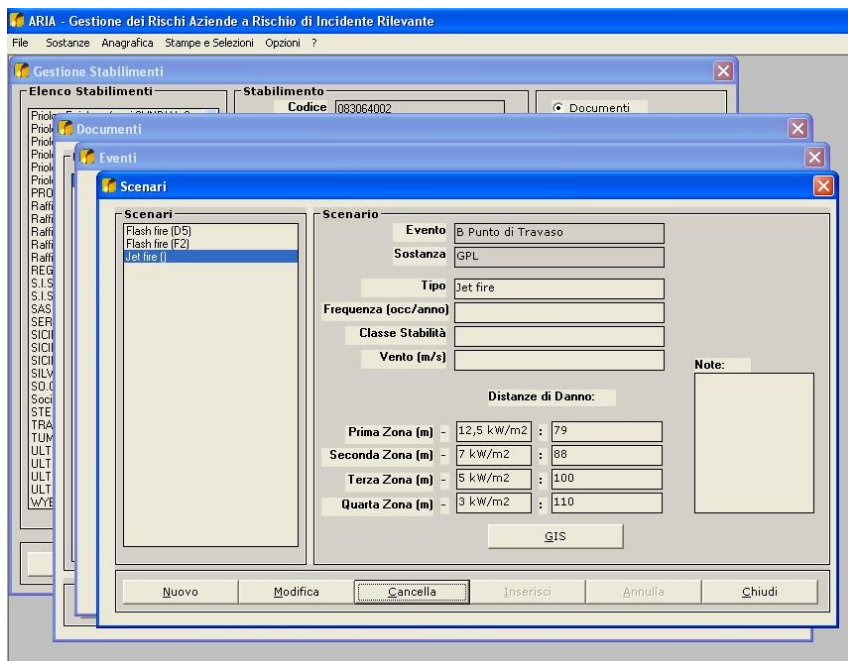
## Strategic Role

- Pilot case for further integrated risk studies in Italy
- Foundation for future Seveso-related planning tools



# Methodological Approach

- Use of GIS application ARIA 334 for georeferencing Seveso sites
- Use of ARIPAR-GIS 3.1 application for quantitative risk mapping
- Focus on fixed plants, pipelines, and transport
- Integration with land-use planning and emergency management



# Phases of the Study (IASS Priolo–Augusta–Melilli)

## Initial Phase (2001–2003)

- Study prepared by industrial operators (coordinated by Confindustria Siracusa, with Snamprogetti as technical consultant).
- Delivered to the Ministry of the Environment in 2003.
- Based on CeA 2002 criteria: area delimitation, inventory of hazardous sources, domino effect analysis, demographic and territorial data collection.

## First Commission Phase (2005–2006)

- Preliminary review of the operators' Integrated Area Safety Study.
- Critical issues highlighted: inconsistencies with CeA criteria, non-uniform methodologies, intrinsic limits of ARIPAR tool.
- Recommendations made on needs to update data on risk sources, vulnerable targets such as people (including workers) infrastructures and environmental targets.

## Second Commission Phase (2006–2008)

- Integration and update of the operators' study.
- Establishment of Restricted Technical Working Groups (GTRs) for specific topics.
- Methodological refinements: ARIPAR sensitivity analysis, cross-check of accident scenarios, validation of territorial datasets.

# Commission Activities

## Phase I

The operators' **initial** study was innovative but methodologically weak.

The Commission and RTWGs added scientific robustness, validated datasets, refined methodologies (esp. with ARIPAR), and issued operational recommendations.

## Phase II

The first report highlighted data update needs (2005 Safety Reports and nearby infrastructures) and the omission of workers in ARIPAR's individual and societal risk representation.

In the second phase, it was necessary to identify internal and external safety measures.

Operators recompiled the risk recomposition into three projects (Plants, Pipelines, Transport), but the latter two were less detailed due to time constraints.

- **IASS realignment:** Update with cartographic support (orthophotos 2000, satellite imagery), in collaboration with report experts; data harmonisation from RdS 2000.
- **Risk Source verification:** Cross-check of sources using updated RdS 2005 data.
- **On-site inspections:** Findings and remarks from Commission's plant visits.
- **Vulnerability mapping:** Identification of additional vulnerable points not included in the original IASS.
- **ARIPAR inputs:** Repositioning and implementation of input data, in collaboration with report experts.
- **Pipeline study:** Development of a dedicated "Pipeline" study by the Operators.
- **IASS update:** Production of a revised and updated version of the IASS.



# Role of the Restricted Technical Working Groups (RTWGs)

## RTWG “Scoping”

set study boundaries, accident scenarios, domino effect criteria, and data requirements.

Created a common baseline: established shared rules and methods for all thematic GTRs.

Ensured consistency: improved comparability of Safety Reports, avoided data fragmentation, and provided a roadmap for the Commission’s work.

## RTWG “Information Systems”

Development of a shared GIS-based information system.

Collection and harmonization of data from operators and authorities.

Production of technical cartography and risk maps.

## RTWG “Infrastructure”

Assessment of transport networks: roads, railways, pipelines, gas pipelines.

Identification of sensitive nodes and overlaps with high-risk areas.

Evaluation of interactions between infrastructures and Seveso establishments.

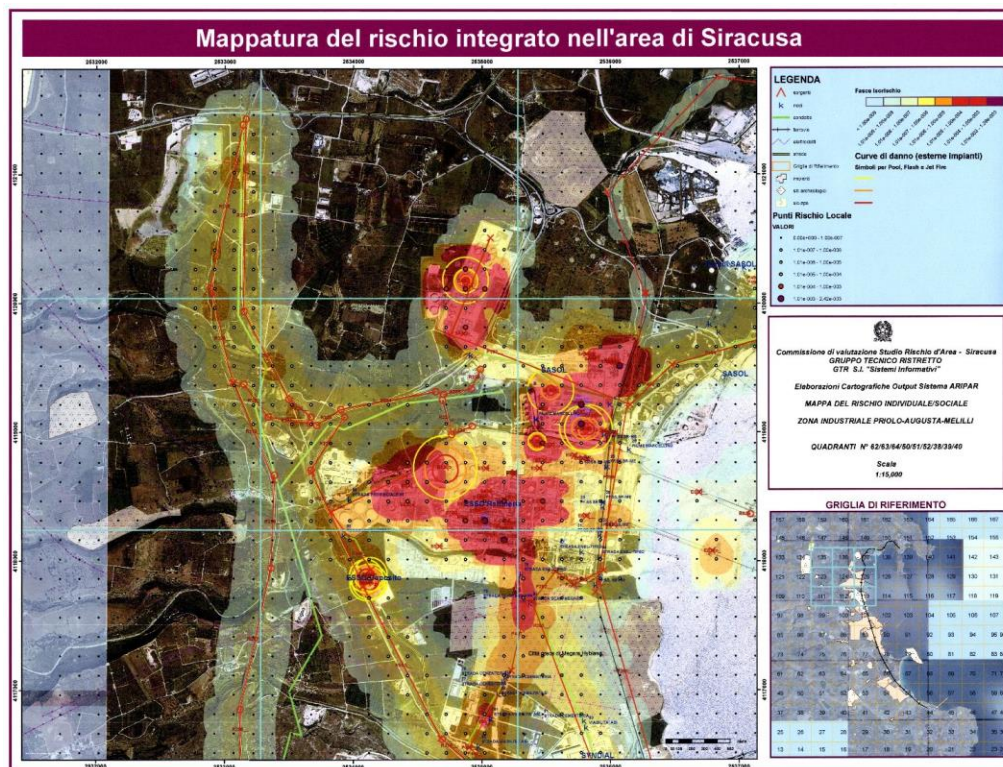
## RTWG “Internal Safety Measures”

In-depth review of industrial accident scenarios submitted by operators.

Verification of consistency across different Safety Reports.

Proposals to strengthen internal safety and prevention systems.

# Spatial analysis and output map of ARIPAR GIS, Individual and Local Risk



ARIPAR outputs show iso-risk contour lines overlapping with high-occupancy and environmentally sensitive receptor and infrastructures.

Multiple nodes above  $10^{-6}$  risk levels

# Recommendations for all operators in the Commission's Final Report

## G1-G3

### G1

**Comment:** Update of SSIA to address limitations identified in study Phase I.

**Description:** Develop a new, comprehensive version of the SSIA, ensuring updated information and overcoming previously highlighted gaps.

### G2

**Comment:** Address safety issues related to abandoned or non-operational installations in the industrial area.

**Description:** Remove or safely manage disused equipment, improve accessibility, inspections, and maintain a decommissioning register.

### G3

**Comment:** Manage environmental risks associated with substances hazardous to aquatic ecosystems.

**Description:** Conduct risk analysis for accidental releases of hazardous substances at major storage points, considering them both as sources and targets, and share results with control authorities.

# Recommendations for all operators in the Commission's Final Report (G4-G6)

## G4

**Comment:** Ensure reliability of safety analyses concerning domino effects over time.

**Description:** Implement measures to guarantee equipment integrity, compliance with procedures, continuous staff training, and sufficient fire prevention resources.

## G5

**Comment:** Reduce risks from transport-related incidents affecting industrial equipment.

**Description:** Protect equipment and plants potentially threatened by road and rail transport incidents.

## G6

**Comment:** Improve assessment of risks associated with transport of hazardous substances.

**Description:** Update SSIA to categorize pipelines and routes in detail, justify deviations from reference studies, consider flashfire/UVCE scenarios, and review response times and mitigation measures.



# Recommendations for all operators in the Commission's Final Report (G7-G9)

## G7

**Comment:** Address risks from infrastructures crossing the industrial area (railways, state roads).

**Description:** Implement preventive and protective measures (e.g., gas detectors) with effective coordination between facilities and infrastructures operators.

## G8

**Comment:** Enhance passive protection at intersections of pipelines carrying hazardous substances with transport infrastructures.

**Description:** Provide separation, containment curbs, accessibility for maintenance, and clear pipe identification at sensitive nodes.

## G9

**Comment:** Implement active protection measures at intersections of hazardous substance pipelines and transport routes.

**Description:** Install foam extinguishing systems, isolate high-hold-up pipes remotely, and integrate fire/explosion detection linked to control rooms and company fire services.

# Conclusions

1. The experience in the industrial area of Augusta-Melilli-Priolo was useful for testing a methodological model aimed at conducting an Integrated Area Safety Study and for the subsequent assessment and preparation of the Intervention Plan.
2. The results of the SSIA, while not allowing for the preparation of a comprehensive proposal for an Intervention Plan due to the limitations outlined above, have nevertheless identified some critical issues regarding the protection of the territory and have highlighted the need to update, adapt and integrate the study.
3. It should also be noted that the SSIA, pending the issuance of a national regulation defining a risk acceptability criterion, provides guidance regarding the type and extent of risks.

# Data Gaps & Methodological Limits

**Input data:** Inconsistent use of RdS data (2000 vs. 2005); need for harmonisation across operators.

**Participation:** Not all Seveso establishments in the area contributed to the SSIA update.

**Vulnerability mapping:** Partial coverage of territorial vulnerable points; limited information on surrounding structures and infrastructures.

**Transport data:** Road network only partially considered; cartographic and traffic data outdated and partly inconsistent with CeA criteria.

**Methodological issues:** Use of specific approaches not always justifiable (e.g., exclusion of workers on site).

**Tool limitations:** Intrinsic constraints of the risk recomposition model.

# Positive Outcomes & Recommendations

Development and testing of a new methodological model

Improved data sharing among institutions

GIS-based risk information system

Cooperation between operators and authorities

Update and refine SSIA with more accurate data

Coordination across municipalities and ministries

Develop area-wide emergency plans and public communication tools



# Thanks for your attention

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