GIS APPLICATION FOR CIVIL PROTECTION AND RESCUE IN THE CASE OF A NUCLEAR POWER PLANT EVENT IN KRŠKO, SLOVENIA

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ABSTRACT

GIS Krško was designed to provide emergency planning for on-site and off-site population in Slovenia, based on potential hazard impacts identified in the facility emergency plan [IAEA, 1986]. The data Base Management System (DBMS) consists of specific and global information levels, i.e. for operational tactical needs. Radiological monitoring includes all the meteorological stations, sampling sites for soil, air, atmosphere and food, iodine and aerosol pumps and the evaluation of critical sectors. The Gauss model simulates the concentration gradients of a nuclear cloud (ηS/h) in the radius of 25 km off-site of the NPP Krško and is calibrated with on-line measured data. The simulation model approach considers fundamental physical and operational characteristics of the evacuation network and the optimisation evacuation route. For the purposes of Protection and Rescue the following data are determined: evacuation centres, shelters, schools, industrial buildings, land use, farms, infrastructure, communications of emergency warning system, civil protection and fire brigade units, rescue equipment, medical aid and institutions, hydrology, digital terrain model and register of the territorial units of Slovenian state territory. The specific data base is graphically transposed using digitalisation of maps on the scale of 1:25000 for 25 km radius off-site of NPP and in-site maps 1:5000 for the radius of 3 km. The global data base for the whole country uses a map on the scale of 1:250000 for the purposes of the structures of the Civil Protection and other rescue units, both alarm and national monitoring systems. GIS is furthermore a useful tool in developing drill and exercise scenarios. In addition, the database, once established, can be used to assess the merits of various management measures aimed at developing an effective, site-specific evacuation plan.

1. INTRODUCTION

The use of dangerous materials in various fields of industry, power production, medicine and research has been increasing over the past [Martinčič, 1992] [1]. In the last two decades in Slovenia, a global safety and protection system has been established consisting of three major parts:

- legislation
- safety and protection system for the normal operation of facilities or the use of dangerous materials and
- emergency planning and readiness for nuclear or any other ecological accident.

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The System for Protection and Rescue is based on the responsibilities of the state and local communities to organise and execute measures and activities for removing the danger of natural and other disasters and preventing as well as reducing the consequences. It is also based on the responsibilities of enterprises, institutions and other organisations to organise and execute essential measures for the protection of employees and property within the framework of their activities. The government is primarily concerned with the systems arrangement of the fields of protection and rescue, research work, execution of national security programmes, organisation of certain rescue units and services intended for assistance to local communities [Ušeničnik, 1993][2]. In 1987, the Republic Civil Defence Headquarters established highly professional emergency units, which represent one component of the global safety and protection system. The Ecological Laboratory and Mobile Unit (ELMU) established at the J. Stefan, Institute within the UNDP project has been recognized as one such unit. Its main objective is detection and determination of accidental pollution of the environment with radioactive substances and specific chemical or biological compounds giving professional recommendations to authorities and organisations responsible for the implementation of protective measures as shown in fig. 1 [NUREG, 1980][3].

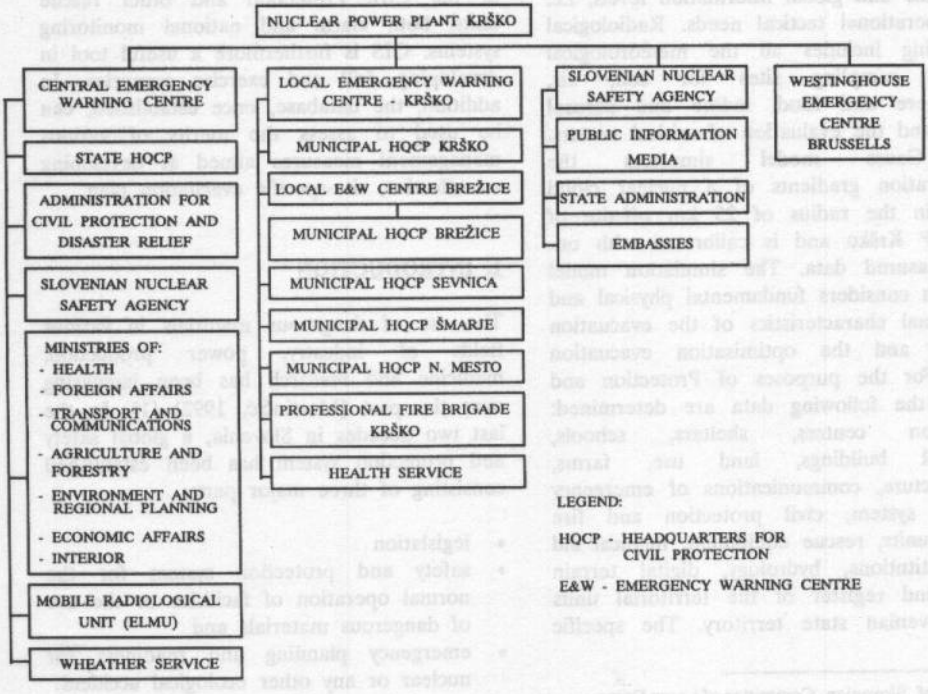

Figure 1: Organisation for directing general emergency planning at NPP event in Krško.

2. EMERGENCY PLANNING AT NPP

Taking into account the recommendations for improvement of operational safety and maintenance in NPP operation, several models are derived with a certain probability of occurrence of an unusual event [Gaertner, 1993][4]. The concept of risk assessment is converted into GIS programming by collecting, combining and using numerical (descriptive) and graphical spatial data. The geodetic base is composed of geodetic codes, topography elements, land mapping, hydrology, infrastructure, terrain, land use and register of local communities and national administration. All data layers are derived from the 1:5000 and 1:25000 scale survey sheets for the purposes of detailed specific database. An overview of the global data base is given from 1:250000 scale maps. A detailed description of GIS database organisational structure is given in figure 2 [Žura, 1993][5].

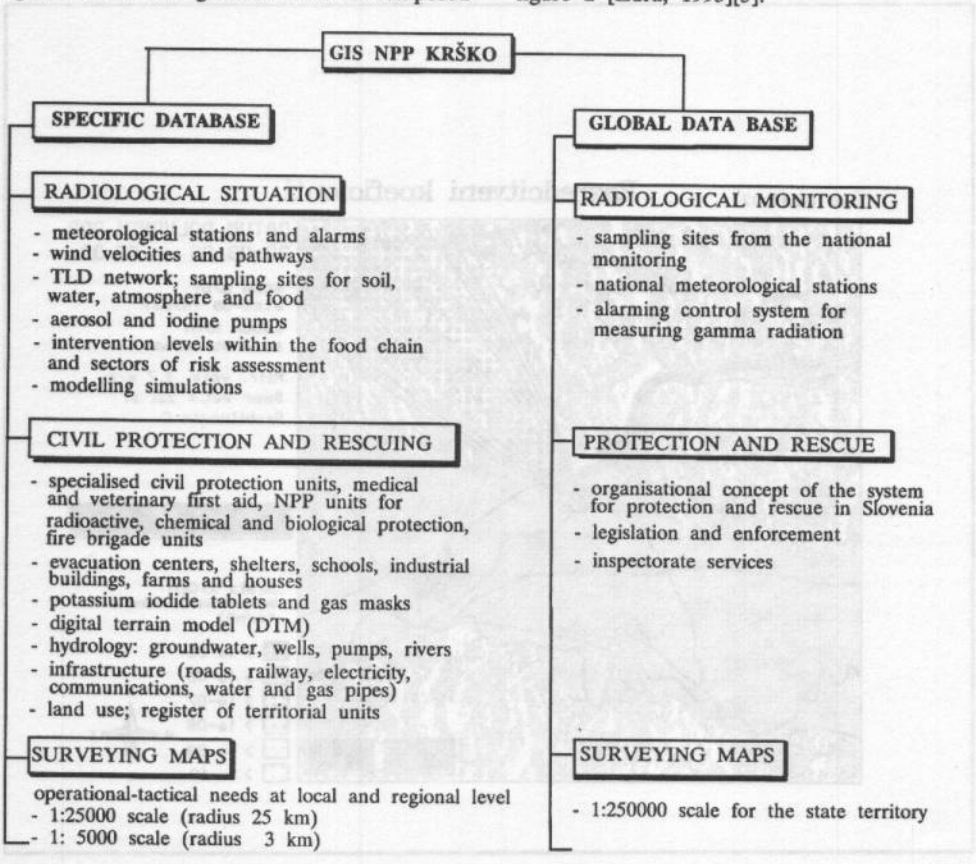

Figure 2: Database structure for GIS application for emergency planning at NPP Krško.

3. RADIOLOGICAL MONITORING

Integrated PUFF programme has the ability to assess real-time and forecast dispersion at un-steady state conditions, also considering spatial and time variability of wind. Radiological dose trajectories are determined for both 10 km and 25 km exposure pathway emergency planning zone. INPUFF model can be used to provide an immediate assessment of initial dose estimates, based on plant-specific radiological and meteorological parameters. Dilution coefficients at 30-minute reporting intervals (fig. 3) show deposition rates and SW direction of the Gaussian cloud. Dilution gradients vary between 10^{-5} to 10^{-10} s/m^3.

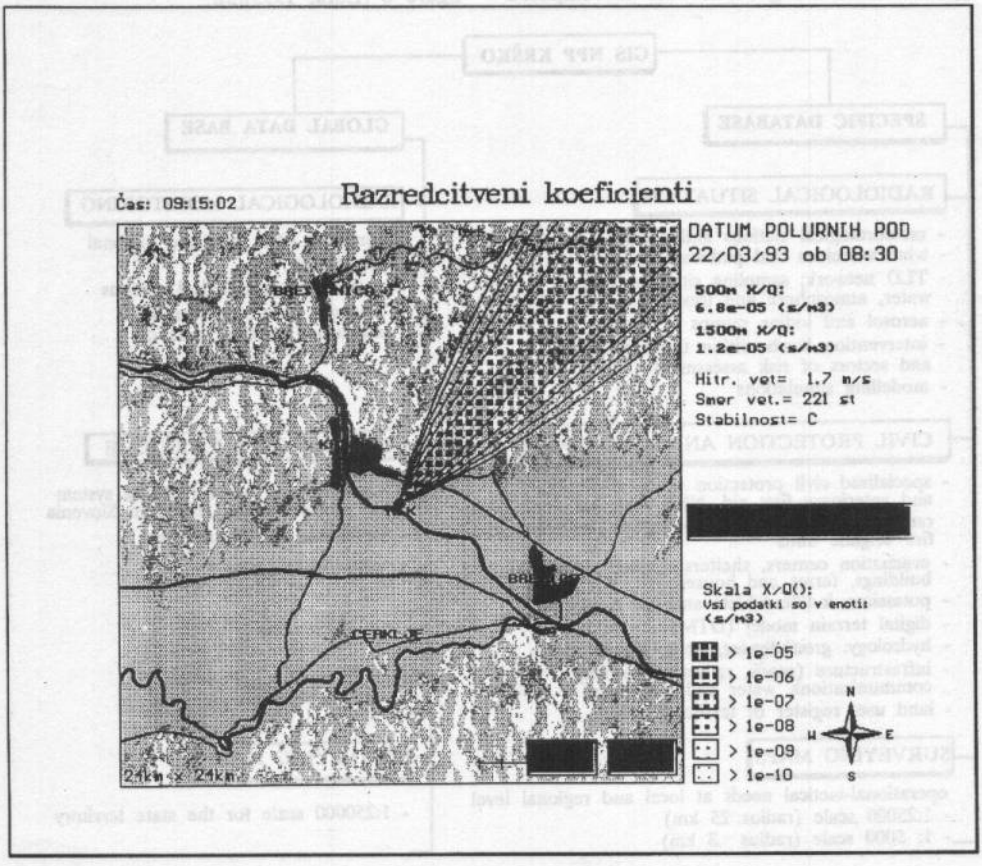

Figure 3.:Radiological monitoring off-site of NPP Krško for an area of 24 km x 24 km (Courtesy of the Agency for Civil Protection and Disaster Relief, 1993).

4 CONCLUSIONS

Physical planning is implemented with spatial and descriptive data for evacuation procedures. The GIS multiple scenario analyses achieved with the computer evacuation simulation model, include population and transportation network data developed through demographic and transportation studies (fig. 4). The procedures are integrated with existing emergency response procedures and contain responsibilities and decision-making checklist format. The structural plan of civil protection and rescue in the case of a Nuclear Power Plant Event is designed in a compatible manner. It can be easily extended for the purposes of emergency planning for other natural disasters in Slovenia. Some advanced techniques are implemented in the project like digital terrain model off-site of the NPP Krško, to determine preferential wind pathways in the surrounding valley of the Sava river (fig. 5).

Hopefully this article will contribute to the international decade for natural disaster reduction action and other relevant efforts elsewhere taking into consideration prevention measures.

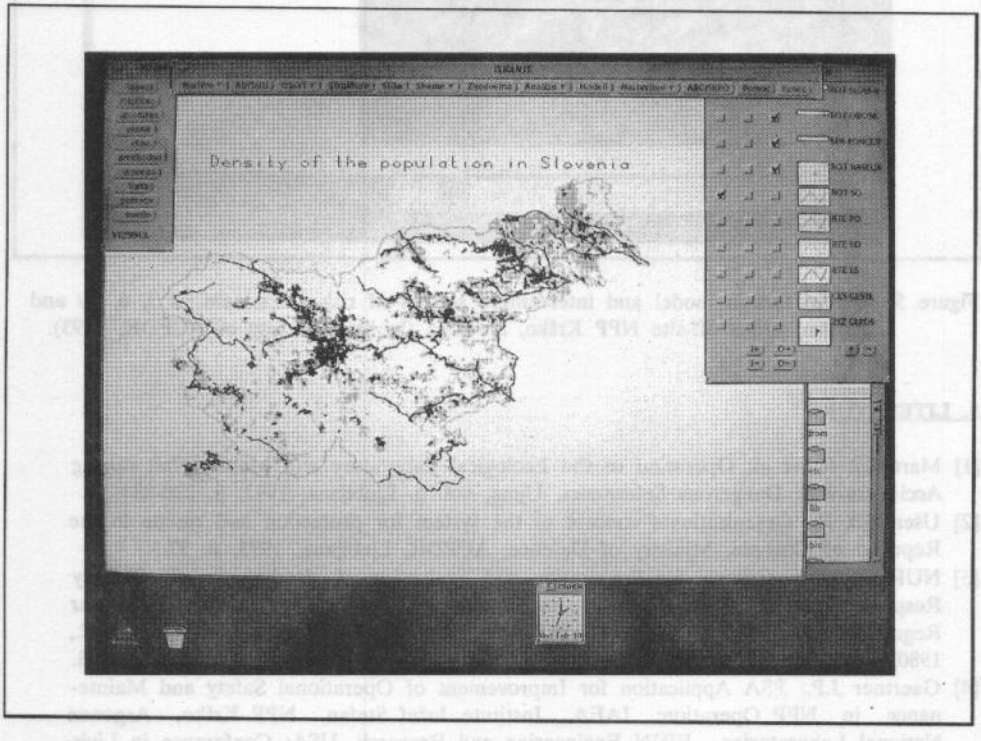

Figure 4.: Demographic distribution of the Slovenian population, ranking from 25, 50, 100 or over 100 citizens/km^2. Major rivers are in the background (By the courtesy of ACPDR, 1993).

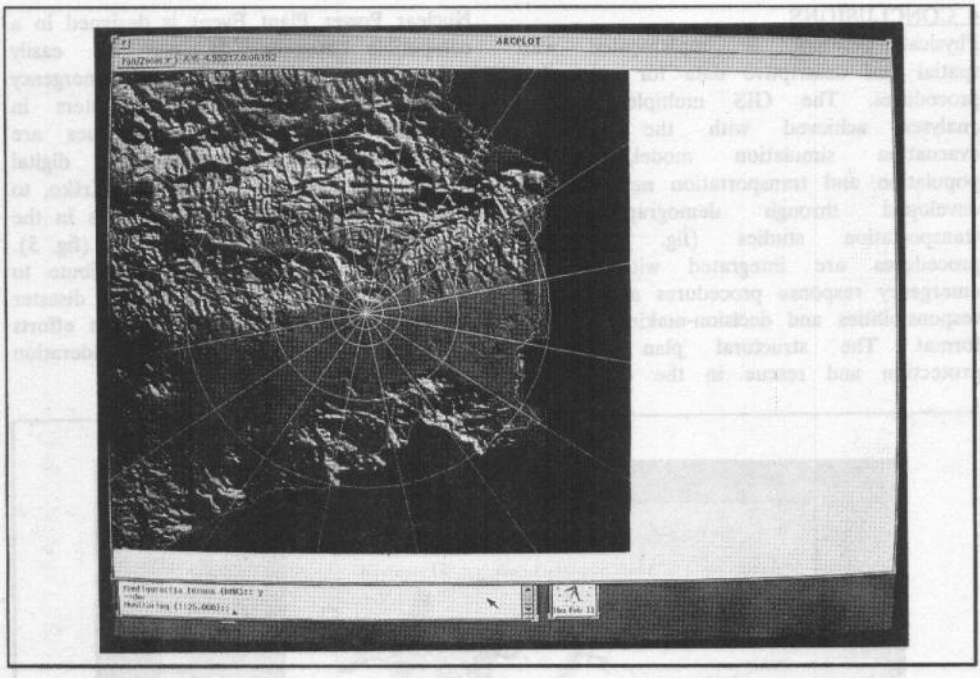

Figure 5.: Digital terrain model and intervention sectors of risk assessment at 3, 6, 10 and 25 km radius off-site NPP Krško, Slovenia (by the courtesy of ACPDR, 1993).

5. LITERATURE

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