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VISUAL SETTLEMENT PLANNING (VISP) A NEW METHODOLOGY IN URBAN PLANNING AND DISASTER MANAGEMENT

Paper prepared by: J. Nieminen, Special Adviser, Data Management UNCHS (Habitat)

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Mr.J. Nieminen
Special Adviser - Data Management
UNCHS (Habitat)
P. O. Box 30030
Nairobi, Kenya
Tel: + 254 2 623201
Fax: + 254 2 624265/624270

ViSP
(Visual Settlement Planning)

MOBILE SUPPORT SYSTEM FOR LAND USE PLANNING AND URBAN DEVELOPMENT

Background

- ViSP is a new approach originally developed in 1991 by UNCHS (Habitat) in cooperation with the Technical Research Centre of Finland (VTT).
- The main objective was to incorporate all necessary statistical and graphical data into a portable format using micro computers or workstations.
- In addition to standard tools (database management systems, spreadsheet, word processing) ViSP has a powerful image processing capability.
- ViSP incorporates photographs, slides, video films, aerial photos, satellite images and maps in the application.
- ViSP enables the user to prepare full color presentations to e.g. visualize different alternatives on real images (video pictures, aerial photos or maps). This technique is effective in providing wider support for the decision making bodies and planners.

Application Prospects

- ViSP is especially useful in the compilation and processing of information on slum, squatter and other informal construction areas for the purpose of planning and upgrading.
- Sufficient information of any area can be collected and processed in a very short time when approximate geometric accuracy is feasible.
- Up-to-date information on the growth trends and physical structures of settlements can easily be monitored and appropriate measures taken with the help of this approach.
- On top of settlement planning applications the ViSP approach has particular potential in:
  - Disaster mitigation and monitoring projects (earthquakes, floods, war destruction areas
  - Environmental impact assessment and monitoring
  - Community participation and public awareness campaigns

Example Methodology of ViSP for Informal Settlement Upgrading

- **Geometric data acquisition:** aerial survey using low-cost photography or video, geometric control by Global Positioning System (GPS), image capture and preparation
- **Attribute data acquisition:** field survey of sosio-economic data, physical characteristic data, infrastructure data and environmental data, input in database management system
- **Data analysis:** statistical analysis and preparation of visual outputs (photomosaic, base map, thematic maps).
- **Settlement planning:** preparation of upgrading plan, presentation of improvement options
- **Implementation and follow-up.**

ViSP -- A NEW METHODOLOGY IN URBAN PLANNING AND DISASTER MANAGEMENT

Jukka Nieminen
Special Adviser, Data Management
United Nations Centre for Human Settlements (Habitat), Kenya

BACKGROUND

Human settlements and the communications, transport and energy distribution networks that link them are the most likely sites for natural disasters. If we are to consider reducing the effects of natural events on the well-being of a country, we must focus on reducing the level of vulnerability of human settlements systems, and in particular those of major concentrations of population.

Some efforts at developing techniques and methodologies for integrating natural-disaster mitigation concepts into physical planning and development are being made:

- seismic engineering into building codes and regulations
- risk zoning becoming better understood by planners

However, we are still a long way from adequate awareness of vulnerability and mitigation of natural disasters. The goal for multilateral and bilateral donors and aid agencies should be to provide maximum assistance to enhance the capacity of governments to integrate disaster-mitigation considerations into their human settlements planning, development and management efforts.[1/]

THE UNCHS (HABITAT) AGENDA FOR MITIGATING THE EFFECTS OF DISASTERS

UNCHS (Habitat) has proposed that efforts in pre-disaster mitigation and post-disaster reconstruction should be focused on the following areas:[2/]

Enhancing the capacity of professionals to incorporate disaster mitigation considerations into the human settlements planning and management process:

- Research into risk and vulnerability of human settlements to natural and other disasters (a multi-hazard approach);

- Development of methodologies for determining risk and vulnerability in human settlements;

- Preparation of guidelines for the incorporation of risk and vulnerability analysis into the human settlement planning and management process; and

- Development of tools (legal, economic, etc.) to encourage disaster-sensitive development.

Enhancing the capacity of the population and governments to reduce vulnerability levels:

- Promotion of a "culture of safety" -- awareness campaigns. Particular emphasis must be given to lower income groups who are generally more vulnerable to disasters;

- An understanding, at the governmental level, of the potential negative consequences of the concentration and/or location of certain activities in terms of increasing risk and vulnerability; and

- The further development of early warning systems to alert populations to impending disasters. In some cases, early warning and protection measures can be very effective in lowering the loss of life and property (hurricanes are a prominent example).

Development oriented post-disaster reconstruction and rehabilitation:

- Reconstruction and rehabilitation of human settlements after a major natural or other disaster entail major investments. These same investments can and should be used to regenerate the economy and reinforce the social fabric that was affected by the disaster.

- Thus, post-disaster reconstruction and rehabilitation activities should be **development-oriented** and not simply concentrate on restoring damaged structures to their pre-disaster condition.

  - Studies on social and economic aspects of reconstruction after natural and other disasters;

  - Preparation of strategies and guidelines for reconstruction after disasters; and

  - Dissemination of guidelines and adaptation to national circumstances through technical cooperation activities.

VISUAL SETTLEMENT PLANNING APPROACH -- ViSP

UNCHS (Habitat), in cooperation with the Technical Research Centre of Finland (VTT), has developed a new approach for urban planners called "Visual Settlement Planning" (ViSP). This development work, which started originally as an urban planning exercise, also serves the agenda presented above.

Over the past years, VTT has developed a computerized approach to land-use planning, incorporating both statistical and graphical data into a portable format using a micro-computer workstation which includes as its basic components a high-resolution screen, optical memory drive, multicolour scanner, slide scanner and multicolour printer/plotter.

UNCHS (Habitat) has helped in building the user interface for the developing countries, making it possible for planners to operate the system with a minimum of training.

The ViSP approach, using off-the-shelf hardware and software, can use satellite images, aerial photographs, normal slides and photographs, and video images as input, thus revolutionizing the traditional methods of physical planning. Also contour lines can be put in over an aerial photo, video image or satellite image. Explanatory text can be shown on the images (e.g., areas prone to flooding or lahar flows) and components can be highlighted (e.g., by numbering buildings). Close-ups can also be imaged, or maps brought in from AUTOCAD to overlay the video image. Using a "paintbrush like" facility, the picture can be retouched, for example by pointing out buildings which would easily collapse in an earthquake or by drawing a scenario of a major disaster over a high-risk residential area.

Global Positioning Systems (GPS) can be linked to ViSP to get accurate location of buildings, bridges and other vital landmarks. This frees the user from the problem of not being able to link the images and photos to the coordinate system. Geometrical image rectification can be done before the digitizing work from full-colour images is started. Photomosaics can be created as long as there is a sufficient overlap on pictures.

The material generated can be viewed on the computer screen, through a video projector, a normal multi-system tv-set, or printed out to show other planners, decision-making bodies, and the community. The possibility for increased community participation, public awareness and the constant monitoring of, e.g., potential natural disaster areas, squatter settlement build up, etc. is obvious.

The ViSP approach can be used in projects dealing with

- urban management,
- physical planning,
- squatter-settlement upgrading,
- geographical information systems (GIS), and
- disasters, natural or man-made.

ViSP AND URBAN DISASTER MANAGEMENT

ViSP as a Tool for Disaster Monitoring

Some natural disasters can be predicted. The path of a typhoon can be calculated and necessary warnings can be given to inhabitants of the affected area. Similarly it is possible to define areas vulnerable to, e.g., floods or lahar flows.

In these cases ViSP can be used effectively in getting reliable material for pre- and post-disaster analysis. When a typhoon warning is given and the probable path of the storm has been defined, the camera crew can fly over the probable disaster area and take aerial photos or video. This material is processed and quick maps and full-colour images are printed for rescue operations.

After a disaster, the same areas will be flown over once again. By comparing the pre-disaster and post-disaster pictures it is possible to get accurate assessment of the damages.

The accuracy of pictures is dependent on the flight altitude, vegetation canopy of the area, weather conditions, and the equipment used for taking photos or videos. A short description of flight altitudes, aerial coverage of different cameras and practical hints to take the pictures is given in appendix 1.

ViSP as a Fast Response Tool

In those disaster cases which cannot be predicted with enough time to get pre-disaster and post-disaster pictures, ViSP can be used for fast assessment of damages, analysis of possible relocation places for the victims of the disaster and fast mapping of the affected area.

The ViSP approach is extremely fast compared to conventional methods of aerial photography or field surveys. It is highly improbable that the disaster area has fresh aerial photos or maps available. It is also improbable that national mapping authorities could mobilize full photography over the area within a short warning time. In these cases low-altitude (500 m–1,000 m) video or photography using a normal 35 mm camera can give fast material for disaster-relief operations. Video images are ready for use practically immediately after landing. Photos and slides cover a larger area in each picture, but take a longer time because they have to be developed. Yet the time required is from a couple of hours (videos) to a couple of days (slides).

ViSP as a Mapping and Thematic Mapping Tool

ViSP can be used for fast mapping in areas which do not have up-to-date maps available. It should be noted, however, that the fast maps are not as accurate as maps prepared by national mapping agencies.

ViSP maps can be made directly from aerial video images. The image is captured ("grabbed") in the computer immediately after the flight has landed. In a couple of hours the first "map sheets" are digitized and plotted for the survey team. The survey team can also use the print-outs of the full-colour images if there is no time to wait for the map to be ready. It takes about ten minutes to print one full-colour image after it is "grabbed" into the computer.

If GPS is available, it is possible to get sub-metre coordinate accuracy after the differential calculations of the defined control points are ready. Measurement of each control point takes approximately ten to twenty minutes. Once this is done all video images or aerial photos and slides can be geometrically corrected. Photomosaics can be produced from the rectified images.

The digitizing work continues when the survey team is in the field. The digitized map will be converted into GIS map base, e.g., through DXF-conversion. The DXF-file can then be imported into most commercial GIS and desk-top mapping packages.

When the survey team returns from the field, its material will be entered into normal dBASE, ORACLE or other database files. These data files will be linked to the GIS map base for the production of the first thematic maps of the disaster area.

In cases where recent maps do exist, the geometrical correction of captured images can be done using the coordinates retrieved from the original map. After the correction procedure the full-colour image can be "rubber sheeted" on top of the map. The extent of damage can then be immediately assessed. If there are numeric maps over the area, quick production of updated disaster maps is possible.

Use of ViSP in Public Awareness Campaigning

ViSP has a very strong image-processing capability. Texts and captions can be added in all picture material. Aerial videos can be "grabbed" in the computer and necessary texts, arrows, boundaries, etc. added so that decision makers and the public can get a better grasp on what actually has happened. Street-level pictures can be linked to aerial pictures through super-indexing.

Public awareness campaigns can make use of the visualization capability by showing local pictures with necessary texts only a few minutes after the pictures have been taken. Planning jargon is not understood by local squatters, but a picture showing, e.g., the flood level during the past disaster in the area, might convince people that their life is in danger.

ViSP USE

A typical ViSP project has the following major steps:

- Collection of existing map material of the affected area
- Preparations to take aerial videos, photos of the area
- Flight over the area (aerial photos, slides, videos)
- Processing of the material acquired from flights
- Capture of video images into the computer
- Capture of slides and aerial photos into the computer
- Geo-referencing of captured material (also use of GPS)
- Geometrical correction of images
- Building of photo mosaics
- Print-outs and "raw maps" for survey teams -- attribute data collection
- Preparation of GIS map base from picture/image material
- Linking collected attribute data to GIS map-base
- Statistical analysis, preparation of thematic maps
- Visualization of picture material (add texts, symbols)
- Preparation of plans, improvement options, etc.
- Awareness campaigns using processed picture and image material
- Implementation and follow-up

Use of ViSP in connection with a recent flood disaster in Ormoc, Philippines is briefly described in appendix 2.

HARDWARE REQUIREMENTS OF ViSP

Recommended hardware requirements for ViSP are:

- IBM compatible microcomputer with 486/33 CPU, at least 300 MB HDD, at least 4 MB RAM, 1.44 MB floppy drive, DOS 5.0, Mouse

- Optical disk drive, if hard disk capacity is small

- Videographics Board ATVISTA 4M/60 (Pal or NTSC) or similar

- NEC Multisync Monitor 4d or similar with analog RGB connector

- Video encoder/decoder (Pal or NTSC, VHS, S-VHS, RGB)

- Still video camera (VHS or Super VHS) Canon iON 260 RC or similar with film adaptor and lens set, or Hi8, or Betacam video camera
- Colour thermal transfer printer or HP Paint Jet (A3 size, 300 dpi)
- Colour scanner (A3 size, 300 dpi)
- Slide scanner (2600 dpi)
- A1 or A0–size digitizing table
- A1 or A0–size pen plotter (eight pens)

FUTURE PROSPECTS - UNCHS (HABITAT) DATA ADVISORY SERVICES

The United Nations Centre for Human Settlements (Habitat) has now completed the system development of ViSP. The Italian Government has agreed to finance a pilot project on the use of ViSP in Kenya. This pilot will test ViSP use especially in squatter–settlement planning. This project will start in January 1994.

UNCHS (Habitat) has the same budgetary problems as most of the United Nations system agencies. In order to develop this approach for disaster management further it will be necessary to find a cooperation partner. A joint project on the practical use of ViSP could be established, e.g., in one of the countries having frequent natural disasters. The UNCHS (Habitat) role would be to give the technical expertise of the approach and to provide training for the project personnel.

UNCHS (Habitat) gives special data advisory services in computer applications in urban and regional planning and GIS. This service is free of charge for developing countries. ViSP use can be demonstrated to member countries as part of these services. The request for a data advisory mission should be sent through the UNDP office of the member country to UNCHS (Habitat) in Nairobi.

APPENDIX 1

HOW TO TAKE AERIAL PHOTOS/VIDEOS FOR IMAGE MOSAICING

Optimum flight altitude depends on the characteristics of the target area, for example, size and type of the buildings, amount of canopy and so on. If altitude is too low, the image area is very small and so the number of pictures to take is large, which leads to tedious aerial photography and post-processing. On the other hand, if the altitude is too high, the quality, accuracy and details may not be sufficient.

If possible, first begin the shooting on a higher altitude and then cover the area from a lower altitude.

The parameters for a camera with 18 mm, 35 mm or 70 mm lens and ground speed of 70 knots (36 m/s) or 100 knots (51 m/s) are as follows:

Focal length (mm)	Height above ground (m)	(feet)	35 x 24 mm image area (m * m)	Approximate 35 mm photo scale	Shot interval in seconds mono/stereo coverage 70 knots	100 knots	Distance btw flight lines (m)
18	350	1150	680 * 450	1:19,400	15/7	10/5	360
18	500	1600	970 * 650	1:27,800	21/10	15/7	520
18	700	2300	1360 * 900	1:38,900	30/15	21/10	720
35	250	800	250 * 170	1: 7,100	5/2	4/2	130
35	350	1150	350 * 240	1:10,000	7/3	5/2	190
35	500	1600	500 * 340	1:14,200	11/5	8/4	270
35	700	2300	700 * 480	1:20,000	15/7	11/5	380
35	1000	3300	1000 * 680	1:28,600	22/11	16/8	540
70	500	1600	250 * 170	1: 7,100	5/2	4/2	130
70	700	2300	350 * 240	1:10,000	7/3	5/2	190
70	1000	3300	500 * 340	1:14,200	11/5	8/4	270

Simple mono coverage is obtained using 20 per cent end lap; for stereo coverage 60 per cent end lap is used. Distance between flight lines is based on 20 per cent lateral lap. To avoid disturbing image motion the shutter speed/exposure time should be faster or equal to 1/250 s. Preferably use manual focusing preset to infinite.

The above parameters assume that the camera is positioned vertically and the longer image side is parallel to the flying direction. **It is important to take the picture as vertical as possible.** Usually there is no camera hole in the bottom of the aircraft. Therefore some special arrangements may be needed, for example, to open the window or to remove the door. Shooting through cabin window is not recommended.

Only high-resolution video cameras (Hi8, S-VHS) and scales 1:10,000 or larger should be used for video capture.

The flight should be performed on adjacent parallel lines maintaining the predetermined altitude and ground speed. Some easy to recognize objects on the ground should be identified, for example main roads, riverbeds, etc. to guide the flight path. It is highly recommended that a flight plan be prepared, which shows the target area, flight path, height above the ground, speeds, etc. The flight plan should be explained to the pilot beforehand on the ground, since communication in the air is not always easy. Remember that heights in this brief are above ground, while aviation usually refers to altitudes above sea level.

A workable shooting position and view should be found and checked beforehand on the ground. When taking the photos, avoid direct contact between camera and aircraft, since vibrations are often present in the aircraft body. Hands or body should be used to isolate the camera from the aircraft body. When on the planned flight path and above the target area, concentrate on taking vertical pictures according to the flight plan. Viewing through the finder is not necessary.

APPENDIX 2

ViSP TEST IN ORMOC CITY, THE PHILIPPINES

Ormoc City on Leyte Island in the Philippines experienced a fatal flash flood on 5 November 1991. According to statistics 4,843 people died as a result of the disaster. The cause of this disaster was analysed to be a multiple effect of a heavy rainfall caused by tropical storm Uring, excess logging activities which have drastically diminished the water-absorbing capacity of the surrounding mountains, high tide, and a damming effect which was caused by debris blocking the water from flowing under Anilao Bridge.[3/] The water level rose more than 6 m in a couple of hours because the bridge blocked the waters. Once the bridge could not hold the pressure any longer all buildings and people were washed into the sea located about 1.5 km downstream.

In June 1993 ViSP use was tested together with the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) in the Ormoc area. PAGASA wanted to test ViSP use for flood prevention and disaster mitigation in flood-prone areas. PAGASA was especially interested in the usefulness of this approach for quick mapping, monitoring of recent squatter-settlement development in danger areas, and awareness campaigning.

A military helicopter was made available for the team to fly over to Ormoc City. During the 45 minute flight some 150 vertical and oblique still video images were taken of the flood-affected area and the surrounding mountains.

The pictures taken of the mountain range confirmed the suspicion that illegal logging still takes place. In the Department of Science and Technology report on the causes of the flood disaster, logging was found to be one of the reasons causing the flood two years ago.

Vertical still video pictures were taken from two different altitudes: 500 m and 750 m. During the flight, the Anilao and Malbasag rivers were followed to their mouths. Most of the flood damage was caused to squatter settlements along the river banks. In particular, the Isla Verde area on Anilao river located just above Anilao Bridge suffered from the flood. It was estimated that altogether 2,000 lives were lost in this area alone. Only two buildings were standing in Isla Verde after the 1991 flood.

Ormoc City arranged for a tour to the disaster areas and the resettlement areas built for the victims of the disaster. Another fifty still video images were taken from ground level. The pictures could show that in spite of the recent fatal disaster, people have started to move back to the area. New squatters are building on exactly the spot (Isla Verde) where the past flood washed hundreds of houses into the sea.

After returning to Manila, the video images were analysed and "grabbed" into the computer. Altogether fifty images were chosen for further processing. All these video images were processed to include text. These pictures can be used for awareness campaigns and visualization of the current situation in Ormoc. PAGASA scientists made all text captions and drawings on the images. Required training was given as the pictures were processed.

One of the vertical aerial video images was used for digitizing the buildings and street network into AUTOCAD format. Digitizing took place from the computer screen where this full-colour raster image was loaded. A special AUTOCAD Driver for ATVISTA 4M Board is needed for this. Since PAGASA personnel had never before used AUTOCAD, necessary training was given during the actual digitizing work. The street network, the Anilao River, Anilao Bridge and approximately 180 buildings on this image were digitized. It took about two hours for an untrained person to do this.

The prepared AUTOCAD drawing had to be converted into a format where a GIS or desk-top mapping package could use it. The UNCHS (Habitat) portable workstation has Map Info as the thematic mapping tool. Through DXF conversion the vectorized (AUTOCAD) material was imported into Map Info. Map Info automatically assigns each closed polygon a reference number which is used to link attribute data to the polygon. In this case it was important to create a GIS map base for buildings. The intention was to produce thematic maps on building materials, roof types, soil types and inhabitants of each building. These maps are of importance in assessing the current situation and the vulnerability of the area to future natural disasters.

Since there were no statistical data available on the current situation in Ormoc, an imaginary database was created consisting of data on soil types, building material, roof material and the number of inhabitants of each building. An estimate of the value of each property was included in the database. This database was built using dBASE III. The building reference number created by Map Info was then used as the link to database records. Several thematic maps were then produced from the attribute data.

All the above mentioned work was completed in a few days. The video flight was arranged on Friday, 11 June 1993. Video images were "grabbed" into the computer on Monday, 14 June 1993. During Tuesday and Wednesday the PAGASA personnel was trained to digitize and edit the picture material. On Thursday the PAGASA personnel designed the database and entered data into it. The dBASE file was linked to Map Info and thematic maps were produced. A demonstration of results was given to PAGASA management on Friday, 18 June 1993.

NOTES

1/ Jukka Nieminen, "Mitigating the Effects of Natural Disasters in Metropolitan Areas", *Habitat News* 14 (December 1992): 22.

2/ Ignacio Armillas, James Armstrong and Jukka Nieminen, "UNCHS (Habitat) and Disaster Mitigation" (Paper presented at the National Hurricane Conference, Orlando, Florida, 13 April 1993).

3/ Ormoc Task Force Scientific Study Group, Department of Science and Technology, *Scientific Assessment Report, Ormoc City Flood on 05 November 1991* (1991).