

**“Preserving the Finger Lakes for the Future”
A Prototype Decision Support System for Water Resource
Management, Open Space, and Agricultural Protection**

Annual Report 2002 - 2003

Submitted to:

National Aeronautics and Space Administration

December, 2003

ANNUAL PROGRESS REPORT OF RESEARCH

RESEARCH GRANT

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Grant Number NAG13-02059

For research entitled:

"Preserving the Finger Lakes for the Future"

A Prototype Decision Support System for Water Resources Management, Open Space and Agricultural Protection.

This is an Annual Progress Report for the period 9/26/02 to 9/25/03.

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For this annual progress report of research, the following summary of significant accomplishments during the above mentioned period is hereby submitted.

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1. INTRODUCTION

As described herein, this project has progressed well, with the initiation or completion of a number of program facets at programmatic, technical, and inter-agency levels. The concept of the Virtual Management Operations Center has taken shape, grown, and has been well received by parties from a wide variety of agencies and organizations in the Finger Lakes region and beyond. As it has evolved in design and functionality, and to better illustrate its current focus for this project, it has been given the expanded name of Watershed Virtual Management Operations Center (W-VMOC). It offers the advanced, compelling functionality of interactive 3D visualization interfaced with 2D mapping, all accessed via Internet or virtually any kind of distributed computer network. This strong foundation will allow the development of a Decision Support System (DSS) with anticipated enhanced functionality to be applied to the myriad issues involved in the wise management of the Finger Lakes region.

1.1 Applicability to the Twelve NASA Earth Science Application Areas

One of the strengths of this project and its concepts is the inherent flexibility and planned applicability to many areas of concern in the Finger Lakes region. As such, the integrated and related technologies of the W-VMOC fit well into several of the twelve Earth Science Application areas. Of these, two are most prominent (Water Management and Agricultural Efficiency) that would benefit from the current structure of the prototype.

Water Management - The Finger Lakes region enjoys an abundance of high quality water in its vast network of lakes, rivers, streams and groundwater resources. Concern for the wise use of these resources is a focal point of this project. In fact, RACNE personnel have adopted the science and philosophy that surface and ground water are a single resource. Therefore, one of the goals of the project is to identify probable areas of surface and ground water interaction, to enable a new way to view environment of the region and expand the it's scope and understanding beyond the boundaries of surface watersheds.

Agriculture Efficiency – Agriculture is a primary industry in this region and is also a primary focus of this project. The RACNE staff is looking to develop a better understanding and a regional view of agricultural protection areas, as well as the conservation of open space. Further, as understanding weather patterns is vital to enhanced farming practices, the feasibility of integrating near real time weather information into the W-VMOC is under investigation (see section 2.3, below). Further, the ability to track storm events that can cause personal, community and economic damage (for example, snow and ice storms) would be an extremely valuable tool and is also being investigated, fitting well into the Disaster Management area.

Other Application Areas - As the project unfolds, RACNE sees the potential for the future DSS and/or its core technologies to have applicability in at least the following areas: Coastal Management; Homeland Security; Public Health; and Ecological Forecasting. As the developing technology integrates the power of traditional Geographic Information System mapping and analysis with the compelling use of 3D interactive visualization, it is apparent that the many tools inherent in the prototype can be used to address a wide variety of issues. By its nature, the

project and technology also support and promote data sharing, agency collaboration and the integration of remote sensing and GIS data. All of these attributes form a solid basis for use in a number of the application areas

2. PROJECT GOALS AND OBJECTIVES

2.1 Define the Functional Needs of the Prototype

- 1) An initial set of functional needs for the prototype will be defined by the RACNE project staff .
 - The initial functionality of the prototype was determined early in the project and includes several primary requirements that form the basis for its ongoing development. These include:
 - The integration of 2 dimensional GIS mapping interface with interactive 3 dimensional visualization technology.
 - The ability to be deployed over the Internet or network providing access for and evaluation by a Stakeholder Group.
 - Inherent flexibility in the prototype to allow the use of a wide variety of data, as well as applicability to many types of projects.
 - The desire to develop a Decision Support System that could be used as a common set of tools that stakeholders in a variety of disciplines could access and use to aid in wise decision making in the Finger Lakes region.
 - A Project Manager was hired to manage all facets of the Finger Lakes Decision Support System (FLDSS) project.
 - A detailed search and review of existing Decision Support Systems has been conducted. The review was focused on, but not limited too, those system used for Environmental/Watershed research, as well as those used or developed by government agencies and organizations at the Federal level and below.
 - A detailed review including testing and assessment of computerized growth models has also been undertaken. The intent is to integrate these growth models into the project as described in section 2.3 below.
 - Integral to the project is the cooperative work with two other agencies: The Central New York Regional Planning and Development Board (CNYRPDB), and the Cayuga County Planning Department (CCPD). The CNYRPDB is conducting work funded through a grant from Housing and Urban Development (HUD) for the conservation of open space and agricultural areas. A logical synergy exists between the two projects on technical, policy and jurisdictional levels. The projects are running on parallel tracks with support from the CCPD for data development and technical assistance. As a coordinating vehicle, monthly meetings are conducted with these two agencies and RACNE to oversee progress of the various facets of the related work and to share ideas, information and task assistance as needed. This combined effort has been given the name Finger Lakes Water Resources, Open Space and Agricultural Conservation Project (FLWROA).
- 2) Water Resource Priority Protection Areas (WREPPA's) will be designated.

- These areas will be designated based on the coincidence of agricultural protection areas, ground/surface water interaction, significant viewsheds and open space, and a variety of other important environmental factors including wetlands, NYS priority water bodies and others. This work is in progress through the assignment of staff to the analysis of each of these components individually. The work will culminate with the addition of all the components to the prototype, resulting in a number of data layers and tools that can be used to identify, review and analyze WREPPA's.
- 3) A first version of the W-VMOC will be implemented based on the defined initial functional management requirements.
 - A first version of the W-VMOC has been completed and is undergoing testing and review toward the addition of greater functionality, as described in later sections.
 - 4) A stakeholders group will be formalized to review, amend, and react to W-VMOC functionality. *This task was completed after the period covered by this annual report (Sept. 26, 2002 - Sept. 25, 2003) but its importance as a key component of the projects warrants brief review.*
 - A Stakeholder group was picked representing all levels of government for the Finger Lakes region. These organizations and agencies were invited to a day long facilitated information gathering meeting on October 27, 2003. Professional facilitators lead the participants from over 25 agencies and organizations through traditional information gathering techniques to identify challenges and opportunities for the wise use of the Finger Lakes region. A live demonstration of the prototype was given including a hypothetical application for watershed planning, followed by additional facilitations to help determine how the prototype technology can be applied to address these challenges.
 - 5) Stakeholder feedback will be derived from this group and summarized in a Management Resources Guide.
 - The resulting information gathered from this meeting will be reviewed and analyzed and will form a basis for the continued development of the prototype. This will be summarized in the Management Resources Guide and provided to NASA for review.
 - 6) **DELIVERABLE:** Implementation of an initial prototype W-VMOC, to be verified by NASA by accessing the prototype via Internet.
 - Implementation and provisional access to the prototype is estimated to be completed by the end of 2003. Access to and demonstration of the W-VMOC prototype will be provided to NASA for review and comment.
 - Up to 6 other organizations and agencies will be asked to participate in testing the prototype to assist in its continued, early development. These participants will be asked to test the prototype for real world projects and to report how well the technology works, its level of applicability to their needs and any other

suggestions they may have.

- 7) **DELIVERABLE:** Completion of a Management Requirements Guide.
 - The Management Requirements Guide is scheduled for completion in the first quarter of 2004, based on information derived from Stakeholder feedback and prototype testing by RACNE staff and external testing assistants. This will be made available to NASA for review. It is envisioned that the document will serve as a primary resource guide to staff for the continued development of the prototype decision support system.

2.2 Derive the Spatial Data Requirement

- 1) A taxonomy of spatial data will be developed, based on the Management Requirements Guide.
 - The taxonomy will facilitate organization and ranking of the importance and coincidence of the data types as the WREPPA's are developed. Based on the ongoing reviews of existing DSS and growth models, a growing understanding of the data requirements for this project has rapidly taken shape. However, this does not preclude the need to revise and refine data needs as the feedback from stakeholders is interpreted. As the information from the stakeholders meeting is reviewed, and the Management Requirements Guide is developed, the structure of the spatial data taxonomy needed will be more fully understood. Further, existing taxonomies will be reviewed; it is probable that an existing structure exists that is suitable for adaptation to this project.
- 2) A review of remote sensing instruments to supply such spatial data will be undertaken.
 - A preliminary review of available remote sensing instruments and the data products they can produce for the study region as been completed. It is anticipated that remote sensing techniques will be applied to satellite derived data for the development of a land cover base for the prototype area. This work is scheduled to begin in the first quarter of 2004. Other applications of remote sensing will include the investigation of the viability to classify impermeable surfaces over time as a possible measure of regional growth in the Finger Lakes region. It is anticipated that the North American Land Classification triplicates derived from Landsat data will be utilized.
- 3) A review of available GIS data will be undertaken from state, local, and commercial sources.
 - A preliminary, comprehensive review of these data sets has been completed (see #5, data matrix, below).
 - To obtain the most reliable data for the local area, funding has been provided to the Cayuga County Planning Department for the development of a variety of data sets to be used for base mapping, modeling and task specific data needs. The target delivery date for this data is January 2004.

- 4) A review of underwater sampling data and other in situ monitoring data (academic, research institutions) to be incorporated in the W-VMOC.
 - In cooperation with a local lake association and others, RACNE plans to fund and oversee the deployment of an automated, robotic buoy in Owasco Lake in the spring of 2004. This buoy is similar to several others used in other New York State waters, including neighboring Cayuga Lake. The buoy will have a group of sensors mounted beneath it. These can be remotely triggered or programmed to be lowered and raised through the water column to take measurements and readings of water characteristics at a wide variety of depths, providing a more realistic general description of the characteristics of the lake than samples taken at a single depth. The captured data is then transmitted to shore for processing. Finally, the buoy will also include an above water "weather station" that can also transmit current weather conditions to shore, providing the potential for access to near real time weather conditions on the lake via the Internet or other means.
 - Academic institutions including Cornell University and Hobart William Smith Colleges have been contacted to discuss water quality monitoring and exchange ideas and information. It is anticipated that dialogs with these and other institutions will be continued indefinitely.
- 5) A matrix of data needs and sources and a list of databases will be created.
 - A draft Data Matrix describing data types and the related sources, scales and other descriptors is currently in development. This will continue to be revised, with special consideration given to the review of the information gained through the stakeholder meeting process (above). This exercise has also helped to begin identifying and quantifying specific data needs for the project, their availability, and level of effort to acquire or develop. Further, a clearer understanding of "standard" base data required for many aspects of the project has emerged, including automated processes such as computerized growth modeling.
- 6) Preliminary costs to deploy and sustain the system will be projected.
 - This task will be completed upon completion of the full data review and finalization of the data matrix, taking into account the issues raised through the stakeholder process.
- 7) Prototype design will be revised to accommodate these considerations, as practical.
 - The continued development of the prototype will be determined in part by the findings in this section.
- 8) **DELIVERABLE:** Completion of a Data Requirements Report.
 - This report is anticipated to be started in the first quarter of 2004 and will serve as a summary of all the components described in this section (2.2). It is envisioned that the data matrix will form the "backbone" for the report, thus serving (with the report) a primary source for RACNE staff to refer to as a valuable resource for the project and development of the next generation of the prototype system. This

report will be made available to NASA for review and comment upon its completion.

2.3 Design and Develop the Prototype System

- 1) Create an end-to-end prototype W-VMOC for identifying environmentally sensitive areas.
 - This work is ongoing as described and supported by the tasks detailed in this document.
- 2) Fusion with a growth model for gauging threats to sensitive areas will be considered.
 - The overall rationale for this work can be described simply. Once environmentally sensitive areas are determined, they can become parameters driving the input for growth modeling. That is, these become clearly defined areas that should receive special attention, to be monitored closely for development pressures, or to be delineated as limited or no growth areas.
 - Through integrated work with the CYNRPDB and CCPD a variety of growth models are currently being assessed for applicability to the project. RACNE is taking the lead in assessing these models; with recommendations being made to the other agencies. It is expected that at least one of the models will be used in active Public Involvement Plans by the CNYRPDB and CCPD. This work will run in parallel to RACNE's project and will likely continue separately for some time beyond the scope of this grant.
 - RACNE envisions the integration of several growth models into the Finger Lake Decision Support System. The rationale for the use of more than one is that no one model can satisfy the needs of every location and application. Thus RACNE envisions a selection of models to provide a strong measure of flexibility in the final prototype.
- 3) The watershed will be searched for environmentally sensitive areas.
 - A primary functional requirement of the prototype DSS is to enable the overlay and visualizations of WREPPA's (above). As such, it is envisioned that this capability and the data to support it will be built into the prototype and tested relatively early in the development process.
- 4) Integration of weather data and information.
 - The integration of real time and near real time weather information is also a goal for the project. As a proof of concept, NEXRAD data was converted and modified into rough representations of cloud patterns moving through the region and displayed in the W-VMOC. This functionality is envisioned to be improved and used in the DSS for a variety of weather patterns and events including rain, snow, high winds and ice storms.
- 5) **DELIVERABLE:** A second version of the W-VMOC will be implemented in a WAN with a 3D visualization portal.

- The second version of the W-VMOC, in essence the prototype Decision Support System, is in ongoing development as described herein. The current prototype includes the accomplishments of enabled WAN or Internet implementation and a powerful 3D visualization portal. As these milestones have been met, RACNE plans a very limited, controlled deployment of the technology to assist in its development. That is, select stakeholders will be asked to utilize the technology and report on its applicability to real life situations, ease of use, technological hurdles etc. Results from this early testing will be combined with internal development and other stakeholder input to help the evolution toward a DSS with enhanced functionality.

2.4 Test and Evaluate the System

Testing and evaluation of the system is currently estimated to begin in the summer of 2004. As the system is currently a preliminary prototype, it has not yet been possible to address most of these sub-tasks.

- 1) The technology will be tested by utilizing both ground-truth and high accuracy reference data.
- 2) Evaluate the capacity for system use for threat assessment in relation to WREPPA's.
- 3) Evaluate the overall performance of the system.
- 4) Project the long-term data support requirements.
- 5) Stakeholder evaluations will be undertaken.
 - It is anticipated that another stakeholder review process will be undertaken to further gauge the applicability, ease of use and technological aspects of the second prototype W-VMOC which is expected at that time have sufficient functionality to be considered the prototype DSS.
- 6) A method for long term monitoring of system impacts will be devised.
- 7) **DELIVERABLE:** Completion of a Test and Evaluation Report.
 - This is envisioned to be a descriptive summary of the tasks listed above. In addition, a white paper investigating long term sustainability of the Prototype will be completed. Initially thought to be a task for near the end of the project, it has become apparent that the various facets and complexities of the system dictate the need to start this analysis sooner. Topics to be include are, but not limited to: ongoing software upgrades and modifications; long-term maintenance of data; data warehousing; maintenance and update of server hardware; and the economics and funding acquisition necessary to enable all of these tasks.

2.5 Undertake Follow-on Education and Technology Transfer Efforts

- 1) Present the system to the Northeast Affiliates Group, GIT workshops and conferences.
 - Presentations describing the project and prototype system have been given to members of the Northeast Affiliates Group, and at several conferences. RACNE will continue to present and demonstrate the prototype as it evolves as often as the opportunities arise through 2004.

- 2) National Association of Counties; Hire a GIT Extension Specialist: Water Resources.
- RACNE is currently building a strong relationship with the National Association of Counties (NACo). Working with NACo, interviews have been held for a Geographic Information Technology (GIT) Extension Specialist; it is anticipated that a candidate will be chosen and start work early in January 2004. The position will be funded through this grant, but the person will be located at the NACo offices in Washington, DC. The GIT Extension Specialist will aid and enhance the presentation of the W-VMOC technology and applications at the national and county levels, as well as perform other tasks for NACo. To enable coherency and consistency with the project, a regular reporting and communication mechanism will be devised between the GIT Extension Specialist and the FLDSS project manager.
 - *Note: At the time of this writing of this report the position of GIT Extension Specialist has been filled.*

3. FINANCIAL SUMMARY

Item	Budget	9-26-02 - 9-25-03	Total	Balance Remaining
Personnel	190,000		0	190,000
Subcontractors	288,300		0	288,300
Consultants	50,000		0	50,000
Travel	56,000		0	56,000
Equipment	6,978		0	6,978
Projects	501,500	71,931	71,931	429,569
Indirect Rate	332,222	25,176	25,176	307,046
	1,425,000	97,107	97,107	1,327,162