Proceedings of the 13th Biennial Coastal Zone Conference
Baltimore, MD
July 13–17, 2003

SPATIALLY INTEGRATED COASTAL PERMITTING SYSTEM (SICOP)*

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Abstract.
Local, state and federal agencies, such as NJDEP, the US Army Corps of Engineers, and local municipalities, enforce a number of regulations for the current land use and environmental legislation. Compliance to these regulations is a complex process. In New Jersey, the permit process also involves the regional planning agencies such as the New Jersey Meadowlands Commission (NJMC) and the New Jersey Pinelands Commission. SICOP is a joint effort between the New Jersey Meadowlands Commission (NJMC) and the Meadowlands Environmental Research Institute at Rutgers University (MERI). It acts as an ``on-line electronic environmental consultant" that provides an effective single electronic interface for the government agencies to deliver smoother and customized permit processing services to the citizens. More specifically, SICOP provides a ``road map," that determines the exact steps required that are tailored for a particular location and activity type based on the regulatory requirements of each government agency. It is a web-based system that simplifies the long and painful process of compliance requirement identification. By simply clicking on a map or entering a few individual preferences, the required steps for obtaining permits are automatically generated along with all the necessary data and forms.
Although SICOP is developed within the context of planning and permits, the research and development work undertaken in this project can be generalized and can serve as a reference model to be adopted by other agencies and services both in New Jersey and in other states.

Theme: Regional Land Management – Economic Development and Public Access.

1. Introduction.

Local, state and federal agencies enforce a number of regulations for the current land use and environmental legislation. Compliance to these regulations is a complex process as it involves agencies such as NJDEP, the US Army Corps of Engineers, and local municipalities. In New Jersey, the permit process also involves the regional planning agencies such as the New Jersey Meadowlands Commission (NJMC) and the New Jersey Pinelands Commission. Large development firms usually use highly skilled environmental consultants to guide their projects through the permitting process. Private citizens and small businesses are subjected to the same regulations, but may not have the resources to hire a consultant. In this project, we propose a system similar to an ``on-line electronic environmental consultant" that will help citizens navigate the coastal wetland permitting process and help them interact with the agencies involved. We call this a *Spatially Integrated Coastal Permitting System* (SICOP). The proposed project builds on some of our recent research work being supported by the National Science Foundation [2,1]. The significance of this project is along the following three dimensions - (1) It helps the

* This project is supported partially by a grant NA17OC2587 from NOAA.
** Project members also include: M. Alpos, D. Guo, C. Hobble, and Yue He.

government agencies to provide an electronic front-end and the ability to interact and integrate data across heterogeneous systems with an effective single interface, (2) It helps citizens by providing a seamless and customized process in pursuing their development efforts, and (3) Our research and development is generalizable and therefore can serve as a reference model to be adopted by other agencies and services both in New Jersey and in other states.

1.1 Scenario.

The following scenario illustrates the complexity involved with compliance of current regulations: *A developer wishes to build a warehouse complex in his property, which is right on the bank of the Hackensack River in Little Ferry, New Jersey. His property is 15 acres (block 108.04, lot 2.04) and is currently vacant. The NJMC zoning for this area is ``Light Industrial and Distribution B." His property is only two feet below the maximum tide level; as such he will need to fill in with some material in order to secure a sound foundation. As a first step, the developer needs to apply to the NJMC for his zoning certificate [9]. Secondly, the developer needs to find out whether his parcel falls into the so-called environmentally sensitive area, such as wetlands, riparian land, and floodplains. In order to verify this fact, he will have to consult the Freshwater Wetlands Map, Tidelands Claims Maps of NJDEP, and County Soil Survey of Natural Resource Conservation Service first. If the wetland is identified and verified in his development area, he needs the following permits in order to construct his project: Army Corps of Engineers Section 10 or Section 404 permit, NJDEP Waterfront Development Permit, Stream Encroachment Permit, Water Quality Certificate and Riparian Grant.*

As the scenario shows, various locational and geographical features such as surface, and topological relationships with sensitive areas, as well as the nature of the activities involved in the development such as fill and dredging, influence what types of regulatory services are needed from which agencies. This involves contacting the responsible individual at each agency, obtaining the pertinent documents, identifying the required permits, submitting the appropriate applications, etc. This entire process, in many cases, is tedious, time consuming and cumbersome. What citizens need is a ``road map," (we call it a *geospatial workflow*) that determines the exact steps required that are tailored for a particular location and development type based on the regulatory requirements [10]. It is desirable to have a system that simplifies the long and painful process of compliance requirement identification. Simply clicking a button on a map or entering a development and a few individual development preferences generates a customized workflow generated along with all necessary data and forms. Our web-based geospatial workflow system, SICOP, aims at accomplishing this by integrating the *regulatory knowledge* and help the applicant in navigating through the complex permit application process.

1.2 Features and Capabilities of SICOP.

The specific features and capabilities of the project include:
(1) A geospatial knowledge base, which captures the available maps and images, databases, documents and web pages provided by regulatory agencies, (2) A coastal development regulatory rule base, which has extracted regulations from various text (e.g., pdf) documents and web pages, (3) Dynamic generation of a compliance workflow

customized for individual cases that take into account location and permit services provided by relevant agencies, (4) The ability to facilitate processing of the regulation applications by State and local agencies without compromising the autonomy of these agencies.

2. SICOP: Description and Approach.

2.1 Inter-agency Workflow System.

We consider the coastal wetland permitting in NJMC area as a process that involves services from several inter-governmental agencies. We call this *inter-agency service* as *inter-agency workflow*. An inter-agency workflow is a set of coordinated individual unit services provided by each agency. For example, unit services include Waterfront Development Permit service, Stream Encroachment Permit service or Water Quality Certificates service by NJDEP, Section 404 Individual Permit service or Nationwide Permit service, by the Army Corps of Engineers, and zoning certificates from local government, *etc*.

With the unit services and regulatory rule base, our SICOP system automatically generates an inter-agency workflow that specifies appropriate unit services required. This rule based inter-agency workflow generation system has several advantages when compared to the manual workflow design system. First, the workflow does not have to consider all possible scenarios beforehand. This rule-based modular approach allows each workflow to be dynamically composed and tailored for individual needs. By separating the regulatory knowledge and procedural knowledge from services, an inter-agency workflow can enjoy various benefits including enhanced flexibility by adapting to changes in regulatory rules or forms that are required, and preserving autonomy of individual agencies in how they process their permit applications.

2.2 Geospatial Permit Workflow System Architecture.

Figure.1 shows the architecture of the SICOP system. Below is a brief description of the various components.

User Interface: Enables an applicant (user) of the SICOP system to identify the exact location of interest either by navigating a map interactively or by entering his location information into the system, and obtain wetland and other regulatory compliance requirements, based on the location of his development and other preferences.

Profile Generation: Collects the user profile by prompting appropriate questions or by retrieving geospatial data, including demographic data, cadastral data, and other geospatial characteristic functions (e.g. distance, wetland, etc.) as in Figure 2. The profile data are fed into the customized workflow generation module.

Workflow Generation: Generates a customized geo-spatial workflow based user profile, service descriptions, and regulation knowledge rule base as its input. The rule extractor selects only the regulation rules that satisfy user profile. The selected rules are used to identify individual agency-specific services and the inter-agency workflows are composed of these services.

Workflow Execution: Schedules unit-services according to the workflow specification, forwards each task to the appropriate agency for execution, and monitors the execution status.

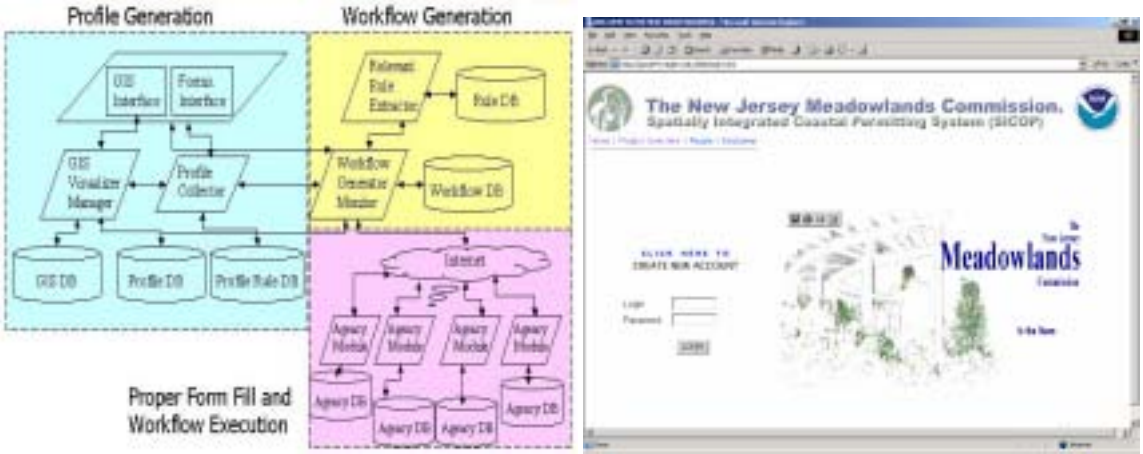

Figure 1. SICOP Architecture.

2.3 Data Collection and Service Description.

Agency-specific service descriptions include not only the service attributes provided by the agencies, but also involve the information needed for interacting with these services [5,6]. This interface information is crucial for workflow since workflow execution component needs to forward the right information for the agency to be able to execute its task [3,8] In case the unit-service is automated, it needs to specify the port or the web link where this service can be invoked. We identify and collect information about component services for the coastal wetland permit and their related data.

2.4 Regulations as Rule Base.

In order to identify the necessary services and documents for coastal/wetland permits, we build a knowledge base made up of all pertinent regulatory rules of the form ``if a certain geographic location and other criteria apply to your situation, then you need this permit." Thus, we consider the collection of regulations as a rule-based expert system, specified as ``Condition-Action" rules. If the condition part of a rule matches the applicant's criteria, then the action part of the rule triggers, inserting the service/permit in action part into the workflow. These regulatory rules, once implemented as service selection rules, automatically identify what services/permits are required in a certain situation, thus mimicking a human expert's knowledge of the regulations. As an example, the rule stating that ``if a location is within a Wetland area in the NJ Fresh Water Wetland Map, then a Waterfront Development/Coastal Wetland Permit is required," can be described in RuleXML [4]. These rules are hierarchically organized as topic ontology for efficient extraction. [6][7]. Some of the regulatory rules need to utilize GIS application tools in order to determine whether the spatial characteristics of the location meet certain conditions. For example, when a rule states that ``if the development area is below the mean high water line, then a Waterfront Development Permit is needed", then a GIS tidal datum function is applied. In this case, the input location is fed into the GIS system where the tidal elevation is calculated to determine whether this rule is applicable. In addition to the regulatory rules, we also consider the service coordination rules, such as "*obtaining tidelands instrument" service* needs to be filed before "*applying for the coastal/wetland permit*".

2.5 Automatic Generation of Customized Workflow.

Given a user profile (location, intended land use, *etc.*), a regulation rule base and service descriptions, the workflow customization design component dynamically generates a workflow that specifies all needed tasks (services at different agencies) in the correct order, and identifies the relevant documents. The location information is matched against the conditions of the rules, firing the actions of the appropriate rules to compose a workflow [7,6-]. The result of the customization module is a workflow specification that guides applicants through the complete permitting process. An example of such a workflow is visually presented to the applicant as in figure 3. A simple click on a task enables the user to execute the necessary tasks.

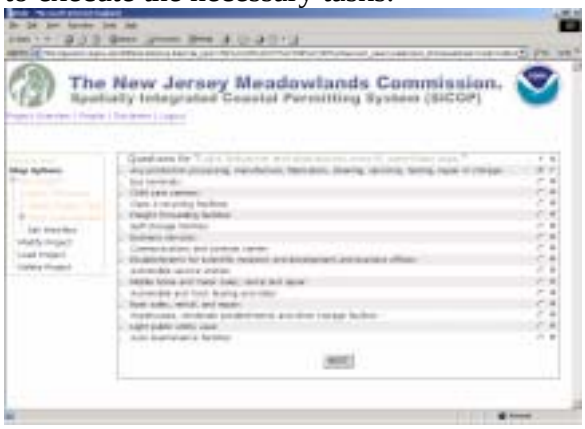

Figure 2. Rule Representation

Figure 3. Workflow Visualization

2.6 Execution of Customized Workflow.

Given the customized workflow specification, the user fills in necessary application information. Once the user information is filled, the instantiated workflow, workflow instance, is ready for execution. The instance of the workflow is automatically readable by each agency that can follow the instructions on what to do in order to process the particular application. When the work is done at one agency, the agency forwards the workflow to the next agency for the next steps to be processed [2, 3, 8]. The SICOP system allows users to avoid entering redundant information at different agencies by forwarding the reusable information from one application to another.

3. Project Partners and Subcontractors.

The project partners consist of New Jersey Meadowlands Commission, the Meadowlands Environmental Research Institute (MERI - is a collaboration between NJMC and Rutgers CIMIC), the NOAA Coastal Services Center, the New Jersey Department of Environmental Protection officials, the US Army Corps of Engineer officials, and 14 municipal government land use officials.

4. Conclusions.

We presented the on-going research and development of the SICOP. SICOP supports citizens and government agencies with spatially integrated coastal permitting services, using component-based geospatial workflow systems. The integrated inter-agency coastal services, composed of individual coastal and environmental services from various

government agencies, provide the *transparency* of underlying complexity of the coordination among government entities, and the *expertise knowledge* of required regulations and information. Our approach automatically identifies, customizes and generates a coastal permit workflow, using regulatory rules, spatial and non-spatial user profile information.

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