Enhancing Permitting Effectiveness using LPA Applications

Case Study
Jurisdiction, Regulation and Permits (JRP) Mapping System for Pacific Northwest Tribes

The Challenge:

The review of permits applied for by developers is a key function of resource managers, especially for Indigenous Tribes in the Pacific Northwest. Through a series of hard won court cases at the state and federal level, the Tribes in the State of Washington regained equal access to natural resources they retained in treaties with the US government in the 1850's. Today, fish and shellfish resources in Washington waters and comanaged by the State and Tribes.

Regulatory Permits are a means for local, state and federal authorities to clarify the scope of impacts of the proposed project and provide permission for those impacts, as allowed by regulations, as long as the project is implemented as designed. When a developer proposes a project that will affect the environment, they are required to submit a permit application to the governing bodies that have jurisdiction over affected natural resources in particular.

The Tribe's mission and obligation is to protect natural resources in their region. The Tribes sought to design and build an application that enables tribal staff to determine which permits are required for proposed development projects. The application must:

a) Make the logic that indicates that a permit is applicable to a proposed project both transparent and editable.
b) Provide an online tool for tribal permit reviewers to locate a project on the landscape, leverage location-based information to answer spatial related questions that determine applicability of permits.
c) Allow the reviewer to fill in all remaining questions relevant to the proposed project.
d) Provide a list of applicable permits to the reviewer, and an explanation of the logic as to why they are applicable based on answers provided.
e) Provide a summary report of applicable permits to the project reviewed.
f) Over time amass a history of permits reviewed that can be synthesized into reports.

JPR Mapping Solution:

The JRP Mapping system was developed in conjunction with LPA's US partners, InfoHarvest Inc. and Mountain View Business Group (MVBG). It is an application on the Ecosystem Management Decision Support (EMDS) platform, which the three companies support.

InfoHarvest was the lead developer working with Northwest Tribes.

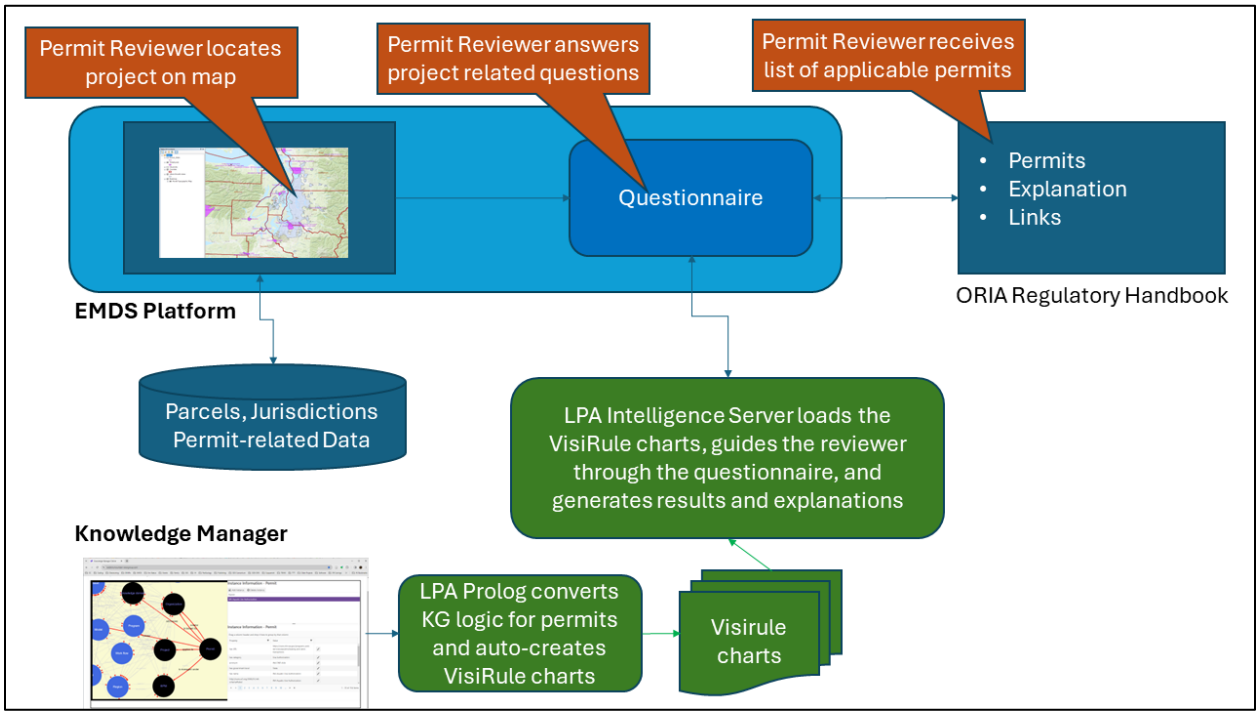

Figure 1 The JRP Mapping solution uses LPA's VisiRule, Flex and Prolog as well as the LPA Intelligence Server to deliver the various services both at development time and at run-time.

Figure 2 (below) contains a concept map showing the various entities involved in a typical permit consideration for a proposal to construct a new dock. A concept map is a diagram that visually represents relationships between concepts and ideas and provides a very useful way of establishing what is involved in any given situation.

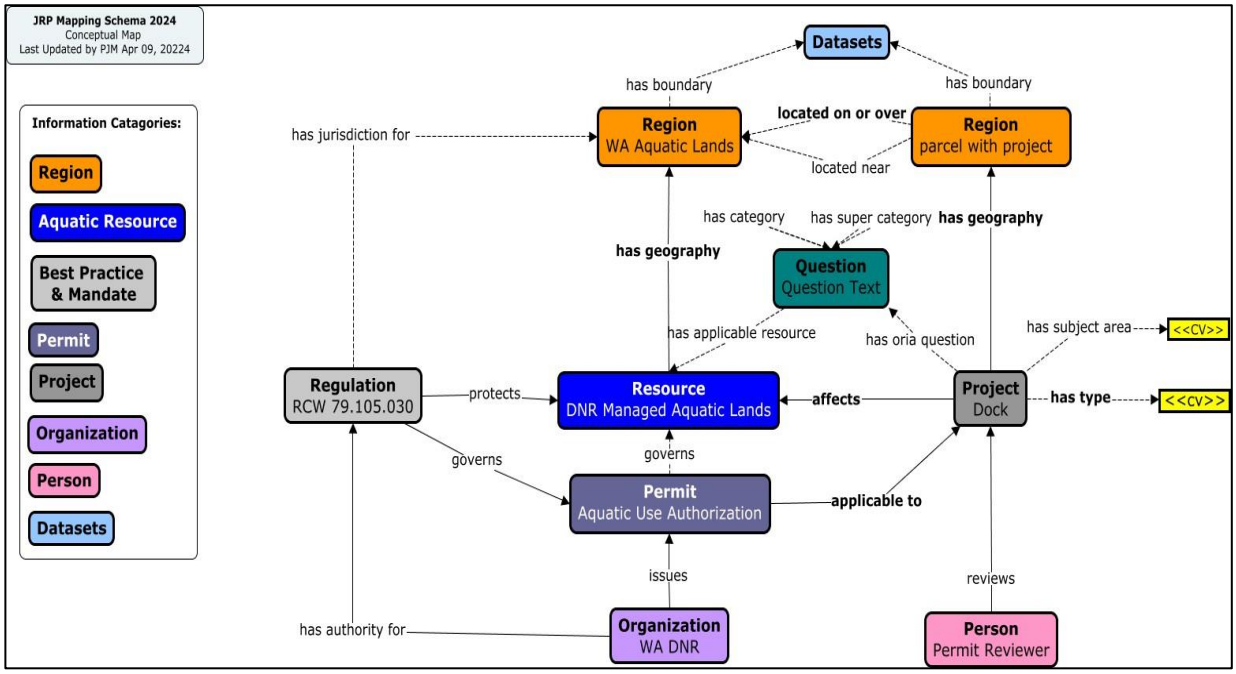

Figure 2 The part of the Knowledge Graph Schema that helps determine the applicability of an Aquatic Use Authorization permit, granted by WA DNR, to a proposed project to create a new Dock. The rectangular shapes are classes (entities) with class names in bold,

In the JRP Mapping system the permit reviewer attempts to answer a series of questions about the proposed project. Typically, a local or state jurisdiction will have emailed the permit application to the tribe to comply with notification requirements. The JRP Mapping solution will help them verify the logic behind the permits that the jurisdiction is already reviewing and identify additional applicable permits for which the developer should be applying. The information contained in the permit received may allow the tribal permit reviewer to complete the entire questionnaire or identify those questions that need further information from the developer.

Some questions can be answered using spatial analysis that uses spatial information about ecosystem resources stored in the Social and Environmental Open Network (SEON) and the proposed project's location on the landscape. For instance, whether the proposed project will occur on, or near, aquatic lands managed by the WA Department of Natural Resources.

Where spatial analysis has already been performed, the JRP Mapping system can ascertain the answer to those questions, and insert them into the **VisiRule** chart, so that the reviewer does not need to answer them manually. Currently, only a handful of questions are answered this way, but over time, it is anticipated that about 30% of the 100+ questions will be answered through spatial analysis.

LPA Capabilities:

LPA's products play key roles in the JRP Mapping system, and its team has been integral in the development of the solution. LPA's knowledge products provide key support to the JRP Mapping System.

LPA Supports the Mapping Project in three ways:

1. Conversion of the Permit Applicability Logic in SEON Knowledge Graph to a VisiRule chart
2. Execution of the VisiRule chart as a questionnaire in online JRP Mapping application
3. Support for general queries in SEON Knowledge Graph

1. Conversion of Permit Applicability Logic to VisiRule Chart:

1. LPA Prolog's efficacy in capturing Knowledge Graph schema and instances as data statements are used to navigate the logic captured in the Social and Environmental Open Network (SEON) Knowledge Graph. It generates a file of logical statements which are stored in an intermediate CSV file. Those statements include the text for the questions and the logic that uses their answers to determine the applicability (or not) of all the permits in the system.
2. An additional Prolog script converts these logical statements into a VisiRule chart containing hundreds of small charts, sometimes called 'chartlets' (Figure 3).
3. The script includes an auto-layout algorithm to arrange the many VisiRule charts in a sensible way (Figure 4)

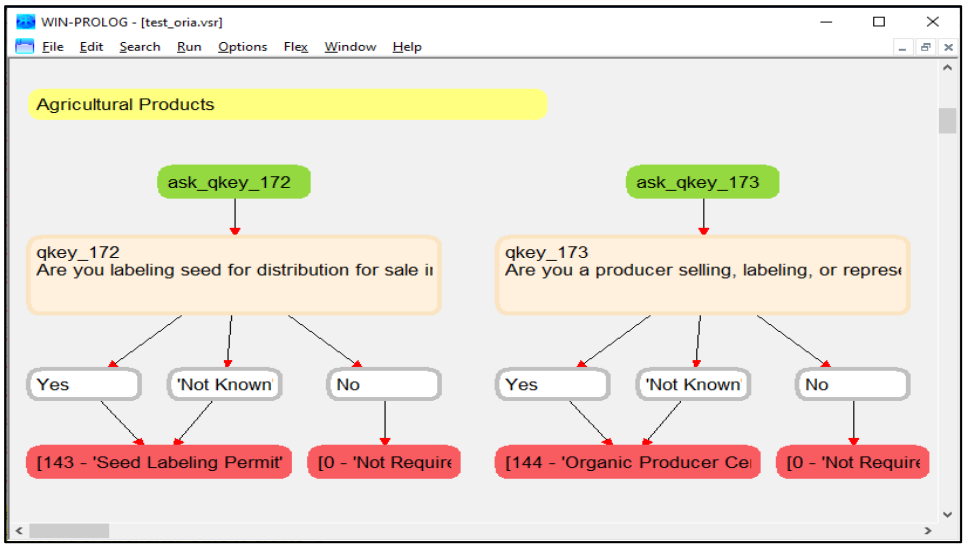

Figure 3 Close-up view of a couple of permit chartlets auto generated from the intermediate CSV file.

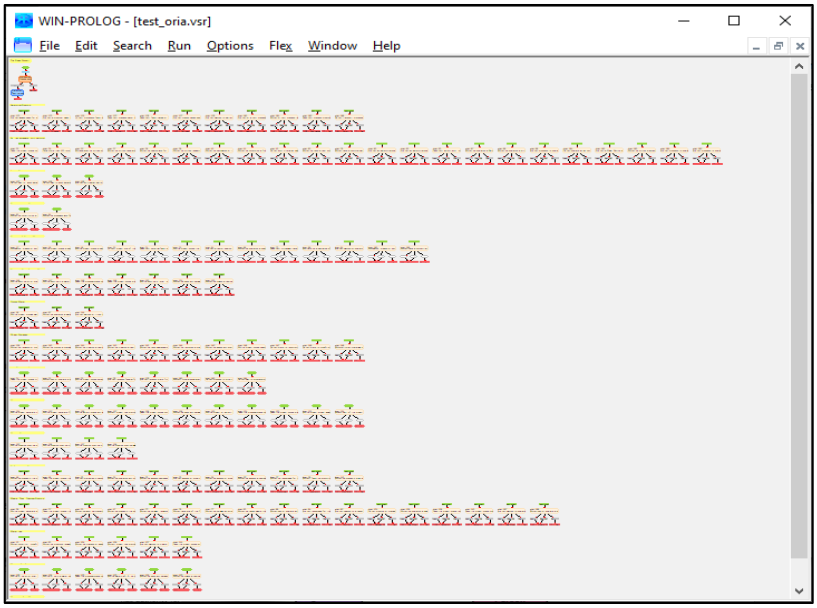

Figure 4 The auto generated VisiRule chart that is comprised of many chartlets and arranged by LPA logic.

Each VisiRule chartlet contains the permit applicability logic for that permit as defined in SEON. Control is with a main VisiRule chart which invokes some Prolog support code which contains a list of categories and associated questions.

2. Execution of VisiRule questionnaire in online JRP Mapping application

Once the LPA Intelligence service has created the VisiRule ORIA chart, EMDS can call the LPA Intelligence Server to query the VisiRule chart and generate the questionnaire which will guide the permit reviewer through an optimized set of questions grouped into categories.

VisiRule uses the answers to determine which permits apply to the specific proposed project. This questionnaire is the heart of the JRP Mapping solution. VisiRule's extendable logic allows it to use the answers to questions that can be answered by spatial analysis based on the project's location, so the reviewer does not have to research the answers to those questions. Once all the questions have been answered, the LPA software returns a list of which permits are deemed applicable and why, based on both the spatial analysis results and the user's answers.

3. Support for general queries in SEON Knowledge Graph

LPA Prolog also provides an efficient way to identifying multiple pathways between instances in SEON based on Knowledge Graph relationships in the SEON KG schema. This enables a deeper generation of SPARQL queries from natural language questions, which the Knowledge Manager uses to query the SEON (and other) Knowledge Graphs in response to users' questions.

Additional Technical Information:

Logic: The initial logic that determines when permits are applicable to projects was developed by the Washington State Department of Natural Resources (DNR). It is currently maintained by the Washington State Office of Regulatory Innovation and Assistance (ORIA). InfoHarvest formalized the logic into triples (subject, predicate, object) that define a semantic schema for a Knowledge Graph.

EMDS

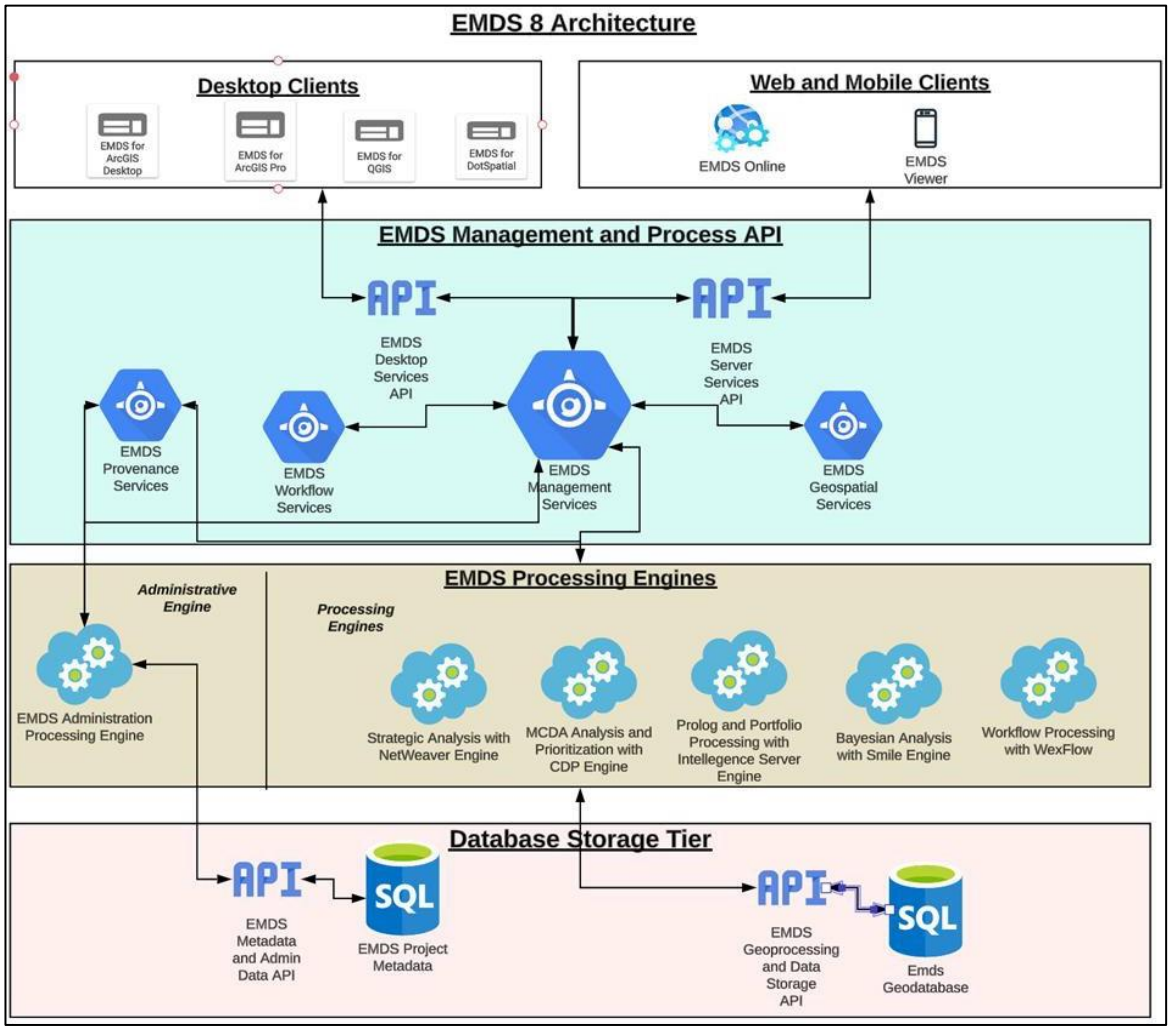

Figure 5 Component Model of EMDS Architecture

Ecosystems Management Decision Support (EMDS)

The Ecosystem Management Decision Support (EMDS) system is an application framework for designing and implementing spatially enabled knowledge-based decision support systems for environmental analysis and strategic and tactical planning at any geographic scale(s). The system integrates state-of-the-art geographic information system, as well as knowledge-based reasoning and decision modeling, technologies to provide decision support for the adaptive management process of ecosystem management.

Initially developed over two decades ago for the USDA Forest Service, EMDS has been used in a wide range of spatial projects. Mountain View Business Group LP (MVBG) is the lead developer for the EMDS Consortium (members - InfoHarvest, MVPG and LPA). MVBG is a company that specializes in building a better working world through their GeoSmart,

Knowledge Management, and Decision Support Solutions. They offer business consulting and training services, as well as cyber infrastructure solutions to the federal government. EMDS currently includes LPA's **VisiRule**, **Flex** and **Prolog**.

Workflow: The workflow of JRP Mapping on the EMDS platform is as follows:

- User selects the location for the project on a map
- EMDS fetches the relevant spatial data from the GIS database
- EMDS asks VisiRule for list of all the categories and associated questions
- EMDS presents the categories to user - user selects all that are applicable
- For each selected category, EMDS presents the questions (between 2 and 17)
- User's answers are collated with spatial data and sent to VisiRule
- VisiRule processes the answers and calculates which permits are required
- EMDS presents details of the permits required with some explanation to user
- EMDS pushes the list of permits required into Postgres DB

Knowledge Manager: Knowledge Graphs are used to encode the model. A Knowledge Graph formally represents semantics by describing entities and their relationships. Knowledge Graphs may make use of ontologies as a schema layer. By doing this, they allow logical inference for retrieving implicit knowledge rather than only allowing queries requesting explicit knowledge.

InfoHarvest & MVBG developed a web-based application to edit, explore and query Knowledge Graphs, called Knowledge Manager. InfoHarvest previously developed the SEON (Social and Environmental Open Network) Knowledge Graph to support decision making for ecosystem sustainability and recovery. InfoHarvest encoded the logic for permit applicability into SEON via the Knowledge Manager system.

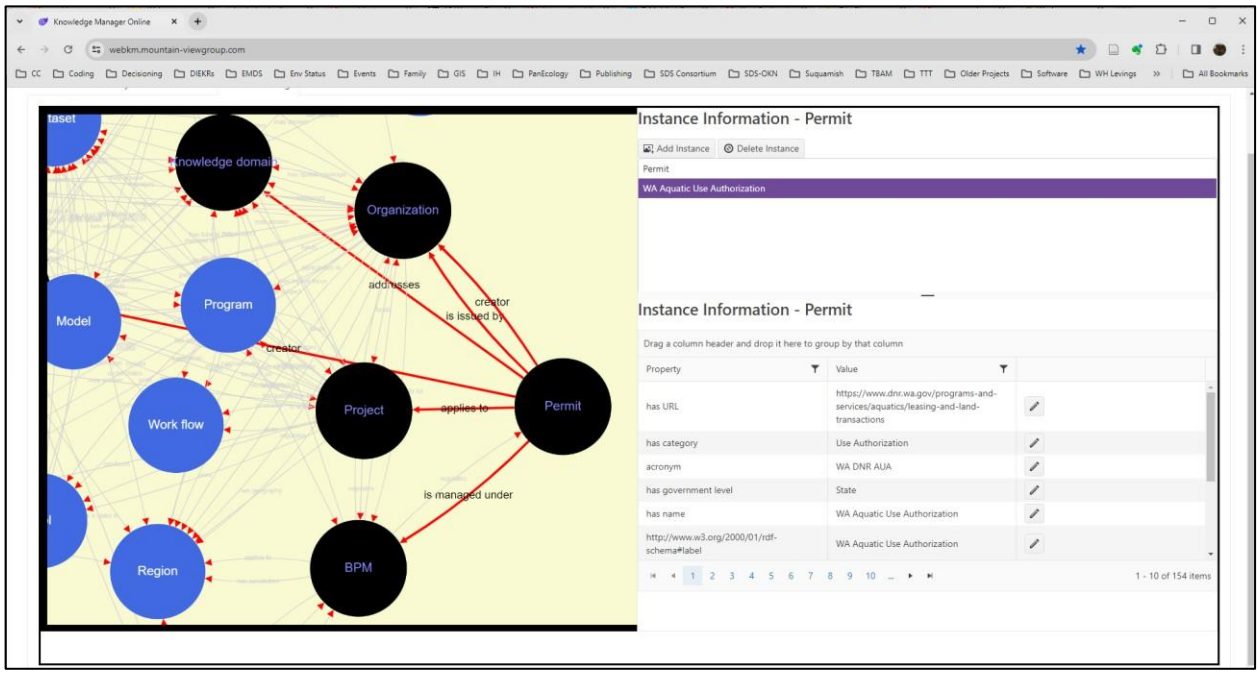

Figure 6: Knowledge Manager view of classes and relationships related to permit applicability

Results:

This document describes the JRP Mapping System, a valuable tool that plays a critical role in allowing for efficient and transparent permit review processes.

Benefits for Tribal Resource Managers:

- **Increased Efficiency:** JRP Mapping automates tasks and streamlines the review process, saving time and resources.
- **Improved Accuracy:** Transparent logic and automated spatial analysis minimize errors in permit decisions.
- **Enhanced Transparency:** Clear explanations for permit applicability build trust and understanding.
- **Knowledge Sharing:** The system facilitates knowledge capture and promotes consistent decision-making across tribal staff, agencies, and developers.

LPA's Key Contributions:

- **Transparent Logic:** LPA Prolog translates permit applicability logic from the SEON Knowledge Graph into a VisiRule chart. This chart visually represents the decision-making process, ensuring transparency for reviewers.
- **Spatial Analysis:** The system leverages LPA's tools and SEON data to answer location-based questions automatically, reducing manual work for reviewers.
- **Dynamic Questionnaires:** LPA Intelligence Server manages the VisiRule questionnaire, dynamically presenting relevant questions based on user selections.
- **Permit Recommendations:** VisiRule analyzes user inputs and spatial data to determine applicable permits and provide explanations.
- **Reporting and History:** The system generates summaries of reviewed permits and maintains a history for future reference.
- **VisiRule Chart Conversion:** LPA Prolog transforms complex permit logic into a user-friendly VisiRule chart.
- **Knowledge Graph Queries:** LPA Prolog facilitates formulating queries to SEON based on natural language for broader knowledge exploration.

Conclusion: LPA's applications are integral to the JRP Mapping system. Their use is instrumental in providing a user-friendly and efficient permit review process. This translates into protection of natural resources and improved decision-making for Tribal authorities.