NORTH OLYMPIC PENINSULA
RESOURCE CONSERVATION & DEVELOPMENT
NOP RC&D

USDA Service Center ▪ 1601 E. Front St., Suite C ▪ Port Angeles, WA 98362 ▪ 360-452-8994

North Olympic Peninsula Solutions Network Project

Summary of Results: National Survey of Resource Conservation and Development Councils

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Executive Summary

The North Olympic Peninsula Solutions Network team conducted a survey of Resource Conservation and Development (RC&D) Councils across the United States to assess the priority issues and needs of the RC&D Councils related to NASA's 12 national application areas. Seventy-six out of 375 RC&D Councils completed the survey, with a broad national distribution of respondents.

Overall, the top priority issue identified by the greatest number of survey participants (53%) was water management, followed by energy management (16%) and agriculture efficiency (11%). Collectively, just over a quarter of all RC&D Council representatives indicated that they or the organizations they work with had experience with NASA data.

The specific management decisions that are most important to responding RC&D Councils within each national application area are summarized in the table below, as well as the data and tools Councils use to support those specific decisions, the proportion of respondents that believe they currently have the information and tools required to make those decisions, and the proportion who indicated they use satellite data to support decision-making for that application area.

Application	Most Important Management Decisions	Data/Tools Most Commonly Used to Support those Decisions	Percent with Adequate Information to Make Decisions in this Application	Percent Using Satellite Data to Support 1st and 2nd Priority decisions
Water management	1. Water quality management 2. Water use for agriculture	1. Direct observation and interpersonal interaction 2. Direct observation and interpersonal interaction	46%	Priority 1: 0% Priority 2: 2%
Agriculture efficiency	1. Invasive species/pest monitoring, management and mitigation 2. Management of field or livestock waste run-off	1. GIS 2. Soil/water data	38%	Priority 1: 2% Priority 2: 7%
Energy management	1. Public education on alternative energy or conservation 2. Optimizing renewable energy production	1. Other resources not specified 2. Other resources not specified	37%	Priority 1: 2% Priority 2: 6%

Application	Most Important Management Decisions	Data/Tools Most Commonly Used to Support those Decisions	Percent with Adequate Information to Make Decisions in this Application	Percent Using Satellite Data to Support 1st and 2nd Priority decisions
Invasive species management	1. Evaluating management actions to control noxious or invasive species 2. Defining strategies to prevent or control noxious or invasive species	1. Vegetation cover data 2. Vegetation cover data	31%	Priority 1: 2% Priority 2: 7%
Ecological forecasting	1. Local/regional land use planning 2. Seasonal cover crop planting	1. GIS 2. soil/water data	43%	Priority 1: 2% Priority 2: 2%
Climate change	1. Creating economic development opportunities 2. Predicting climate change effects on agriculture	1. GIS 2. Climate data *and* soil/water data	29%	Priority 1: 2% Priority 2: 4%
Disaster management	1. Land use planning decisions to manage flood, drought or wildfire risks 2. Predicting and managing areas vulnerable to floods and droughts	1. GIS 2. Climate data	41%	Priority 1: 2% Priority 2: 6%

The findings from this survey indicate that there is interest in and room for improved decision support in a number of NASA national application areas. Once barriers to the use of NASA satellite data among the RC&D Councils is better understood, this may represent a large opportunity for NASA to enhance decision-making for RC&D Councils across the country.

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1. Introduction and Summary Data

1.1 Background

The North Olympic Peninsula Solutions Network team conducted a survey of Resource Conservation and Development (RC&D) Councils across the United States to assess which of NASA's national application areas are considered most relevant to the priority issues facing RC&D Councils. The survey included seven of the twelve national application areas: Water Management, Agricultural Efficiency, Energy Management, Ecological Forecasting, Invasive Species, Climate Change, and Disaster Management.

The survey was specifically designed to:

1) Help NASA and the Solutions Network team understand the types of issues facing RC&D Councils and the decision-making processes used to address these issues

2) Help identify four RC&D Councils that can benefit from the Solutions Network approach used to support water management through this project.

The survey was implemented using Survey Monkey and can be viewed in Appendix A. The survey was sent out by the National Association of RC&D Councils (NARC&D) to all 375 Councils.

A summary document entitled "How NASA Activities Can Benefit RC&D Council Members" was developed to describe relevant NASA data and data products and provide examples of how NASA data could be used to support specific management decisions in six of the priority areas. This document was distributed along with the survey link, and can be found in Appendix B.

1.2 Survey Respondents

A total of 76 RC&D Councils participated in the survey, which represents a 20% response rate. Not all participants responded to all questions, therefore response counts to some questions may be less than 76. The geographic location of survey respondents is mapped in Figure 1 below.

Figure 1. Geographic location of survey respondents

1.3 Priority Issues

The RC&D Council representatives were asked to rate the importance of each of twelve issues (i.e., the NASA national application areas) to the area that their RC&D Council serves. Responses were provided on a scale of 1 to 7, where 1 was "not important" and 7 was "very important." The median of all responses is summarized in Figure 2 below. Topics of greatest importance to the RC&D Councils are first water management, followed by energy management and agriculture efficiency.

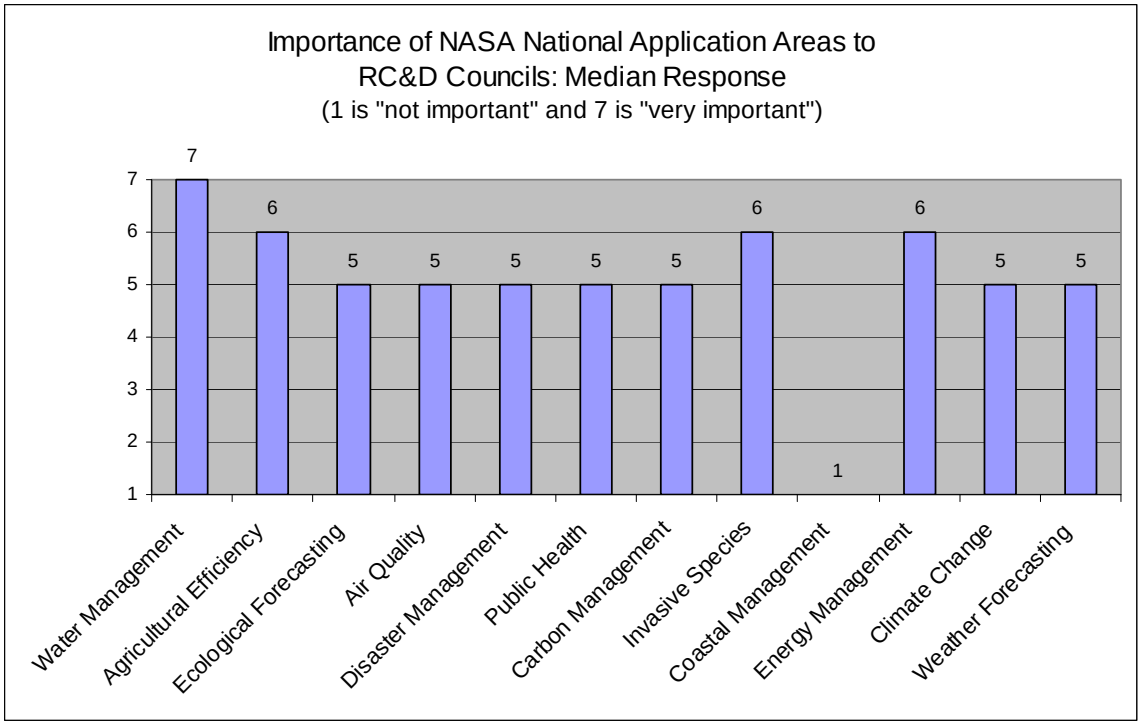

Figure 2. Importance of NASA National Application Areas to RC&D Councils

Figure 3 illustrates the proportion of RC&D Council respondents who consider the different issues to be very important (i.e., a score of 6 or 7). Eighty percent of survey respondents identified water management as very important, followed by energy management (74%), agriculture efficiency (68%), and invasive species (64%).

In general, almost all of the national application areas appear to have broad relevance to the RC&D Councils. Very few identified any of the topics as not important, as illustrated in Figure 4 below. Coastal management was the lowest (61%) as might be expected for any RC&D without a coastline. Other topics that the highest percent of respondents ranked as not important included weather forecasting (16%), climate change (12%) and disaster management (11%).

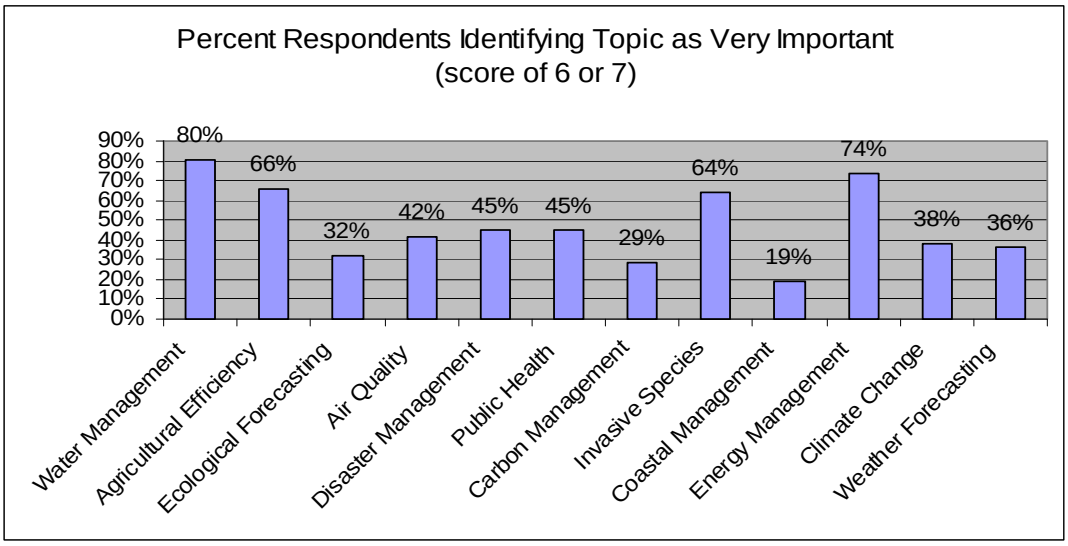

Figure 3. Percent of respondents identifying topic as very important (score of 6 or 7)

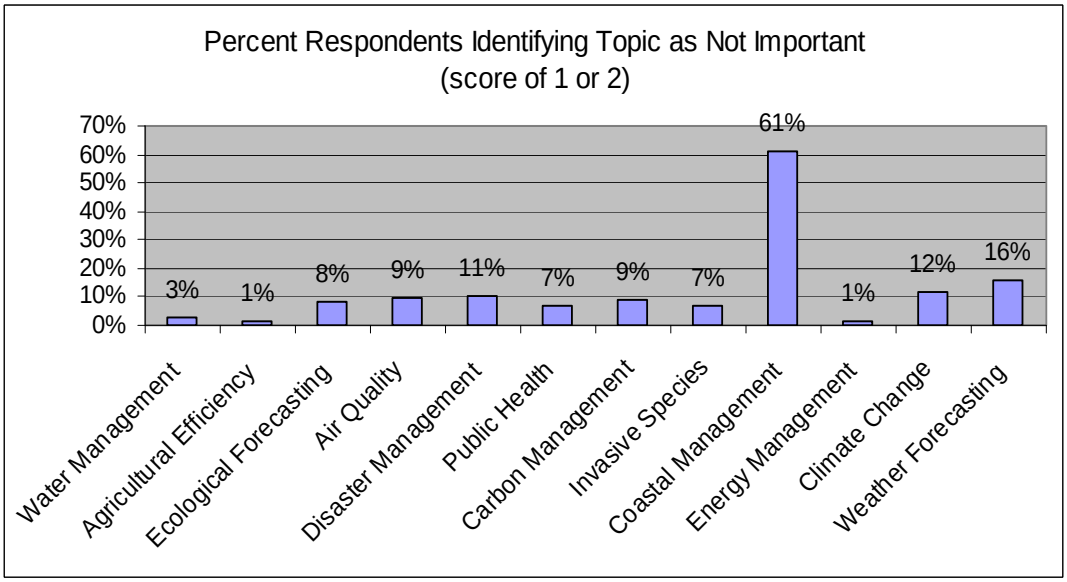

Figure 4. Percent of respondents identifying topic as not important (score of 1 or 2)

Finally, the RC&D Councils were asked to identify which of the 12 issues listed was the single most important to the area served by their RC&D Council. Water management was cited by 53% of respondents as the single most important issue, as illustrated in Figure 5. The next most frequent response, energy management, was only cited as most important by 16%.

Figure 6 shows geographic distribution of respondents by their highest priority management decisions. Those most concerned with water management are distributed throughout the country. Those most concerned with invasive species management are clustered in the northern Great Plains states, and the few most concerned with agriculture efficiency are be clustered in the northeast.

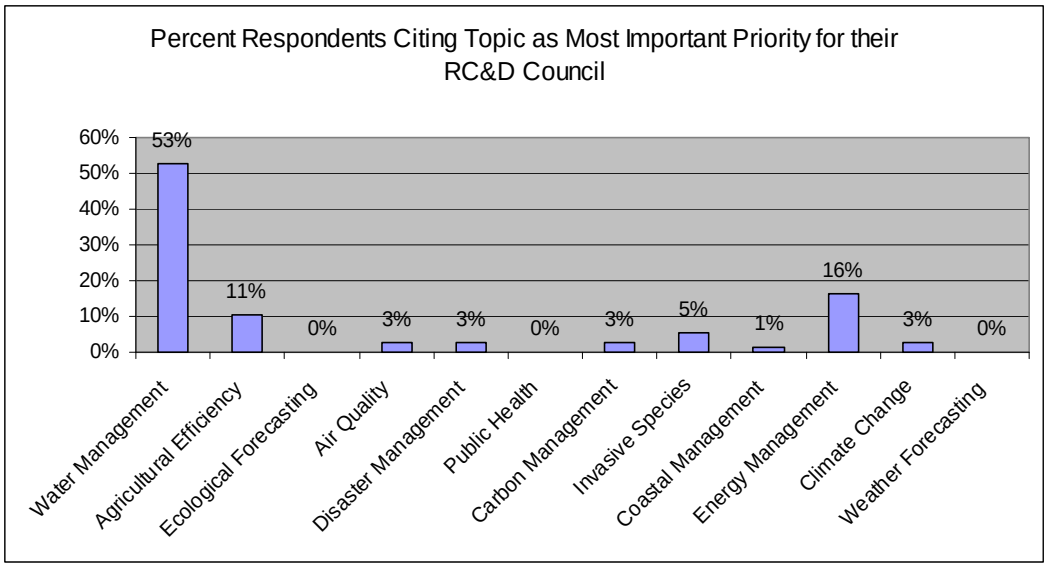

Figure 5. Percent Respondents Citing Topic as Most Important Priority for their RC&D Council

Figure 6. Map of highest priority issue by RC&D Council

1.4 Experience with NASA Data

The RC&D Councils were asked whether they had experience with NASA data or data products. Only 27% of RC&D Council representatives indicated that either they or the organizations they work with had experience with NASA data.

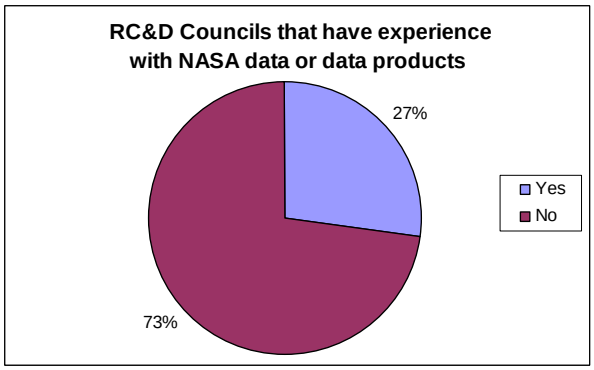

Figure 7. Percent of RC&D Councils that have experience with NASA data or data products

1.5 RC&D Council Collaborators

To help assess the primary constituents of RC&D Councils, survey participants were asked what types of organizations their RC&D Council worked with most to achieve its resource management goals. All but three respondents indicated they worked with multiple types of organizations. As shown in Figure 8 below, local governments, as well as state and federal governments, are the most common collaborators. Tribes and irrigation groups are the least common collaborators for the survey respondents. Several others identified nonprofit organizations and soil and water conservation districts as primary collaborators, and just a few listed private companies, utility districts, and economic development organizations.

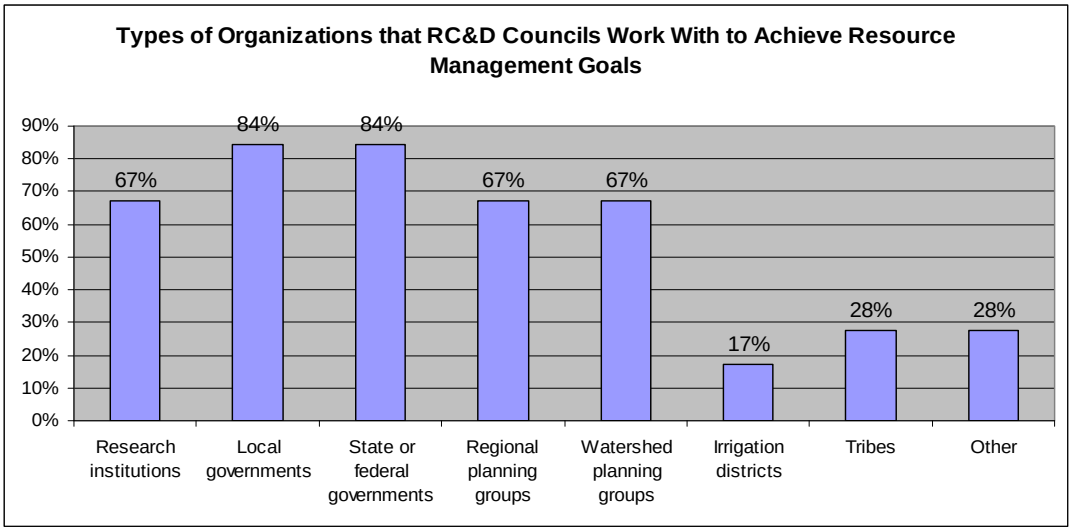

Figure 8. Types of organizations that RC&D Councils work with to achieve RC&D resource management goals

2. Priority Management Decisions and Supporting Data and Tools

For the seven NASA national application areas that were considered most relevant to the RC&D Councils, survey participants were asked to provide more detailed information on their first and second priority resource management decisions and the data and tools used to help make those decisions. For each topic, participants were also asked whether they had adequate information necessary to make decisions. These results are discussed below.

2.1 Water Management

Summary data on the first and second priority water management decisions are presented in Figure 9 below. Nearly half of respondents cited water quality management (e.g., stormwater inputs and field run-off) as their first or second priority decision, followed by water use for agriculture (35%) and water use for domestic, commercial, municipal or industrial (DCMI) activities (31%).

The "other" priority water management decisions, identified by 10% of respondents, included: soil retention/conservation; salmon habitat management (e.g., commercial fishing, tourism, subsistence, recreation); predicting and managing runoff from snowpack to support endangered salmonid species, hydropower generation, irrigated agriculture, domestic water use, municipality expansion, and environmentally sound development;

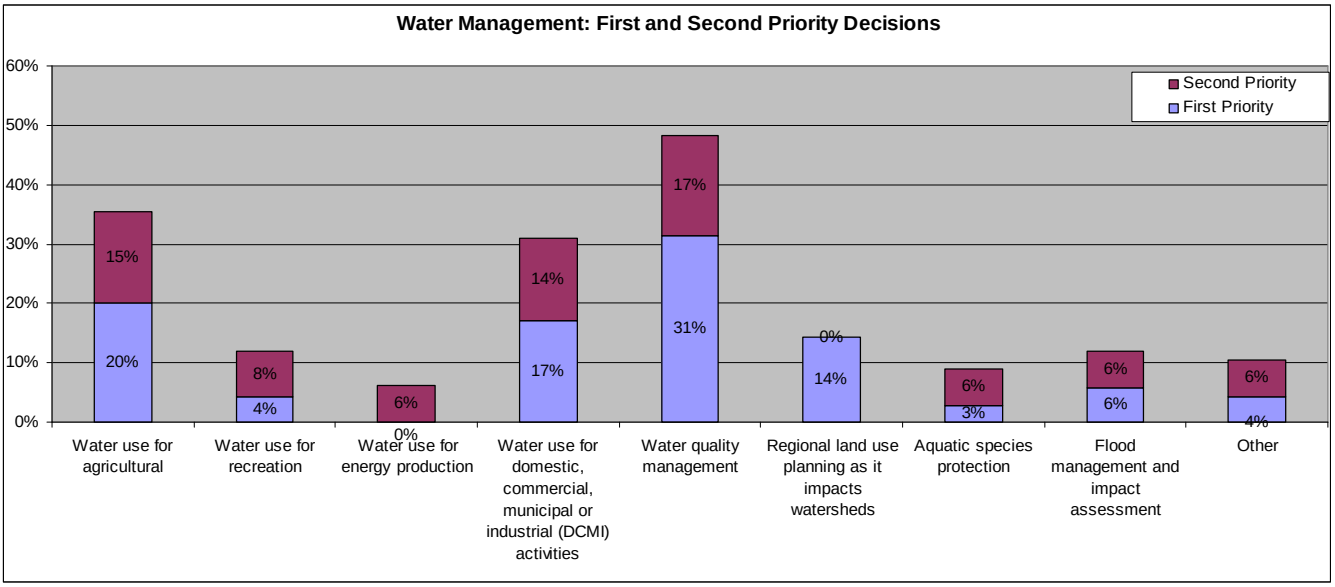

Figure 9. First and second priority water management decisions

the impact of drilling and commercial use on an aquifer drinking water source; transmission of invasive species via waterways; and water availability for fire fighting.

When asked what data and tools were used to support the specific water management decisions above, the vast majority (a total of 68%) rely primarily on direct observation or interpersonal communication to help make water management decisions (Figure 10). Use of geographic information systems (GIS) and water level data were the next most common tools used to support water management decision making, as cited by 38% and 32% of respondents respectively. Only two percent of respondents use satellite data for water management decision making.

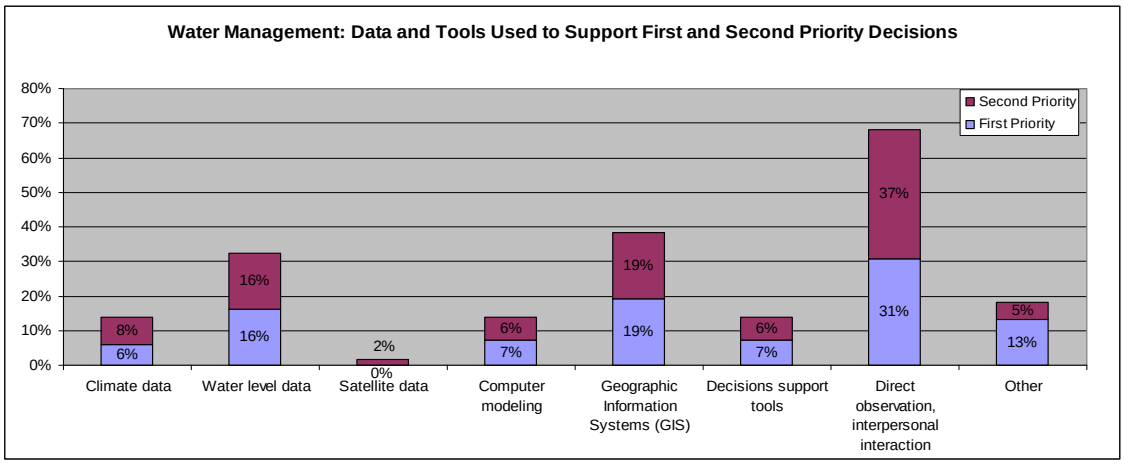

Figure 10. Data and tools used to support first and second priority water management decisions

Data and tools used (Figure 10) were also examined relative to the specific water management decisions identified in Figure 9.

- Of the 24 respondents identifying water use for agricultural purposes as a priority water management decision, nine (38%) rely on direct observation and interpersonal interaction to support those decisions; five use GIS (21%); three use water level data (13%); and three use climate data (13%).
- Of the eight respondents identifying water use for recreation as a priority water management decision, three (38%) rely on water level data to support decision making; two (25%) rely on direct observation and interpersonal interaction. One (13%) uses computer modeling and one (13%) relies on stream segment analysis.
- Of the four respondents identifying water use for energy production as a priority water management decision, three (75%) rely on direct observation and interpersonal interaction to support decision making. One (25%) uses water level data.
- Of the 21 respondents identifying water use for DCMI as a priority water management decision, six (29%) cited use of water level data to support those decisions; five (25%) use water level data; five (25%) rely on direct observation and interpersonal interaction; four (19%) use GIS; and just one each (5%) use satellite data, computer modeling, and climate data.
- Of the 33 respondents identifying water quality management (e.g., stormwater inputs and field run-off) as a priority water management decision, 12 (36%) rely on direct observation and interpersonal interaction to support those decisions;

three (9%) use decision support systems; three (9%) use GIS; two (6%) use water level data; two (6%) use climate data; and six (18%) rely on other forms of data and tools.

- Of the 24 respondents identifying regional land use planning as it impacts watersheds as a priority decision, 11 (46%) cited the use GIS to support decision making; four (17%) rely on direct observation and interpersonal interaction; three (13%) use water level data; and three (13%) use decision support tools.
- Of the six who identified with aquatic species protection as a priority decision, three (50%) said they use computer modeling to support decision making; and two (33%) use direct observation and interpersonal interaction.
- Of the eight who identified with flood management and impact assessment as a priority decision, four (50%) said they use direct observation and interpersonal interaction to support decision making. Two (25%) use GIS and two (25%) use water level data. Just one (13%) uses decision support tools.

Finally, RC&D Council representatives were asked if they thought they had the information necessary to make adequate water management decisions. Just under half (46%) of respondents indicated that they did (Figure 11). Of the 31 who elaborated on their needs, 14 cited the need for better water supply related data and tools (e.g. models), including the need for more accurate streamflow predictions for mountain snowpack areas. Some of those cited the need for real-time and seasonal information to support water use decision making. Ten respondents said they had a need for water quality monitoring, including the need to better understand land use impacts on water quality.

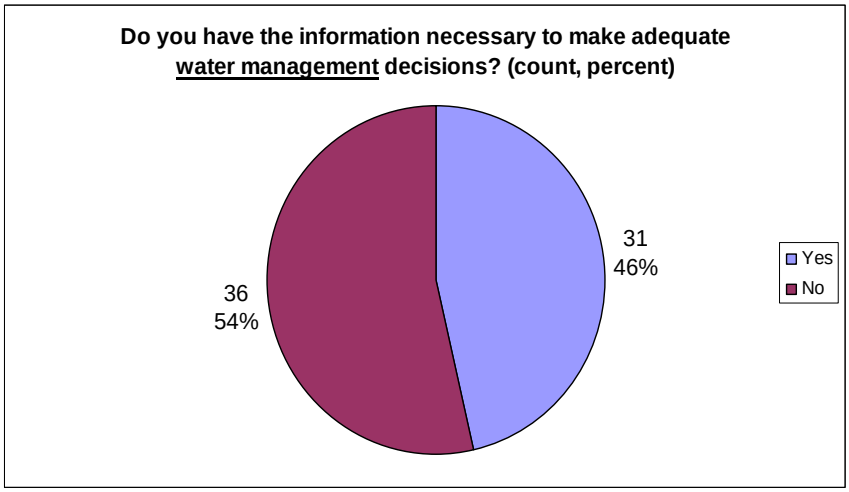

Figure 11. Respondents that have the information necessary to make adequate water management decisions

2.2 Agriculture Efficiency

Summary data on the first and second priority agriculture efficiency decisions are presented in Figure 12 below. Collectively, those decisions that the most respondents identified as the first and second highest priorities were invasive species monitoring, management, and mitigation (32%) and management of field or livestock waste run-off (31%).

For the 10% of respondents that identified priority agriculture efficiency decisions other than those listed, one reported the need to manage urban sprawl into rural areas that have traditionally supported agriculture, and preparing for catastrophic storm events (e.g. flooding). Currently they rely on climate data to support this second analysis. A second respondent cited the need to manage conflicting demands for irrigation, hydropower generation, endangered species, and growing municipalities, and noted that they use computer modeling to support decisions. A third RC&D identified the need to network fragmented agricultural lands to support the economies of scale required to keep the industry viable, and said they use computer modeling to support this type of decision making. Finally, one respondent identified soil moisture management as a priority agriculture efficiency decision, and they rely on soil/water data to support those decisions.

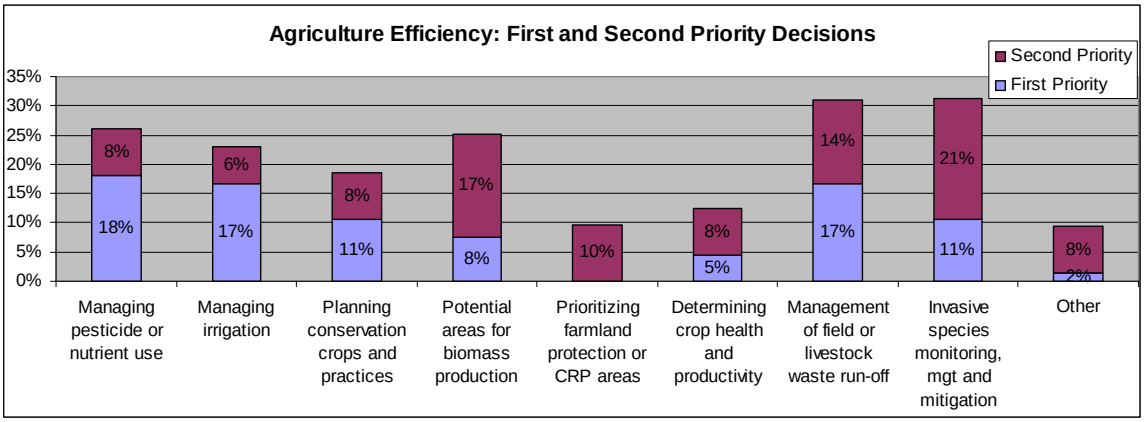

Figure 12. First and second priority agriculture efficiency decisions

When asked about data and tools used to support agriculture efficiency decisions, nearly all respondents rely on soil/water data (92%), followed by use of decision support tools (39%) and GIS (30%) (Figure 13). While still not widely used, satellite data appears to be more frequently used by the RC&D Councils survey for agriculture efficiency compared to the other national priority areas.

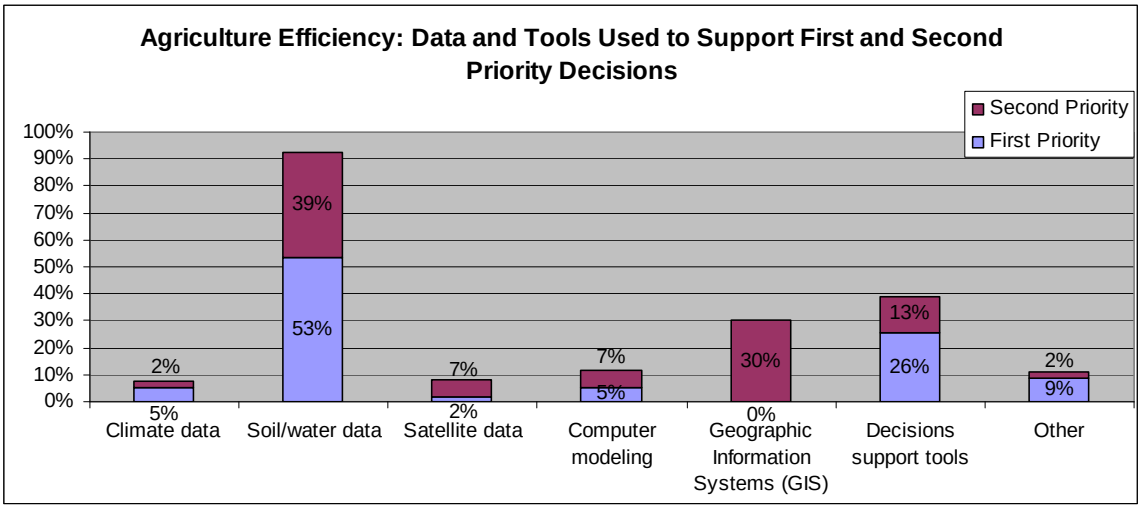

Figure 13. Data and tools used to support first and second priority agriculture efficiency decisions

Data and tools used were also examined relative to the specific agriculture efficiency decisions identified in Figure 12.

- Of the 17 who identified managing pesticide or nutrient use as a priority decision, 8 (17%) said they rely on soil/water data to support those decisions; three (18%) rely on decisions support tools (e.g. Animal Waste Management Software, WIN-PST); and one each (6%) reported using computer modeling, GIS, and climate data.
- Of the 15 who identified managing irrigation as a priority decision, nine (60%) said they rely on soil/water data to support those decisions; two (13%) use computer modeling; one uses GIS; one (7%) uses climate data; and two (13%) did not specify.
- Of the 12 who identified planning conservation crops and practices (e.g. alley cropping) as a priority decision, five (42%) said they rely on soil/water data to support those decisions; two (17%) rely on GIS; and three others (25%) did not specify what data or tools they use to support decision making.
- Of the 16 who said identifying potential areas for biomass production was a priority decision for their RC&D, nine (56%) indicated they rely on GIS to support decision making; four (25%)rely on soil/water data; two (13%) rely on satellite data; and one (6%) did not specify.
- Of the 15 who identified prioritizing farmland protection or Conservation Reserve Program (CRP) areas as a priority decision, six (40%) said they rely on GIS to support decision making; five (33%) use soil/water data; one (7%) uses decision support tools (e.g. Animal Waste Management Software, WIN-PST); and three (20%) cited "other" data and tools, including data from county and state sources to show land use patterns.
- Of the eight who identified determining crop health and productivity as a priority, four (50%) use soil/water data to support decision making; one (13%) uses decision support tools (e.g. Animal Waste Management Software, WIN-PST); and

two (25%) use another source of information not listed, including crop yields and working with university extension professors.

- Of the 20 who identified management of field or livestock waste run-off as a priority decision, 11 (55%) said they rely on soil/water data to support those decisions; six (30%) use decision support tools (e.g. Animal Waste Management Software, WIN-PST); and one (5%) each use GIS and climate data.

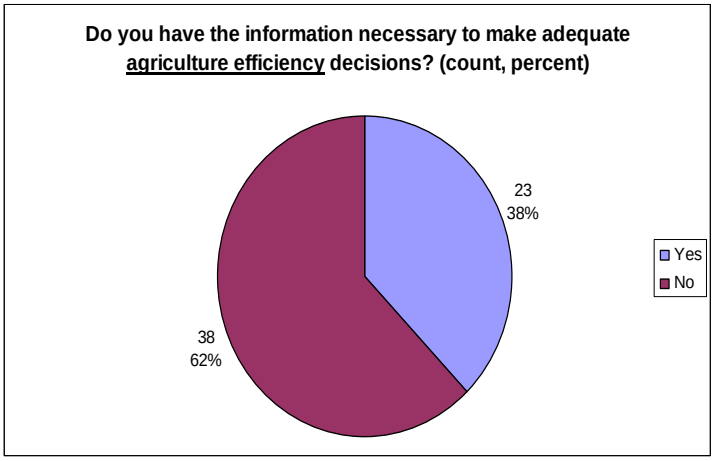

Figure 14. Respondents that have the information necessary to make adequate agriculture efficiency decisions

- Of the 20 who identified invasive species and pest monitoring, management and mitigation as a priority decision, nine (45%) reported they use GIS to support decision making; five (25%) use some form of direct observation; one uses satellite data; and one (5%) uses soil/water data.

Finally, when asked whether they had the information they needed to make adequate agriculture efficiency decisions, only 38% said that they did. Of those who elaborated on their needs, six respondents cited the need for improved water quantity and availability data. That included the need for better soil moisture content data to support precision agriculture practices at the local level, as well as regional scale data on soil moisture across agriculture, rangeland, and forest land cover types. Respondents also cited the need for better real-time water availability predictions incorporating streamflow, aquifer, and above-ground storage. One said they wanted to understand climate change impact predictions on seasonal water flows in snowpack regions. Other information needs noted were: areas affected by invasive species, better weather data at the farm/site level, better land use cover and change data (e.g. farmland conversion and forest cover), and soil quality data to support smart growth while preserving prime soils for farming.

2.3 Energy Management

Summary data on the first and second priority energy management decisions are presented in Figure 15 below. Collectively, those decisions that the most respondents identified as the first and second highest priorities were public education on alternative energy and conservation (70%) and optimizing renewable energy (41%).

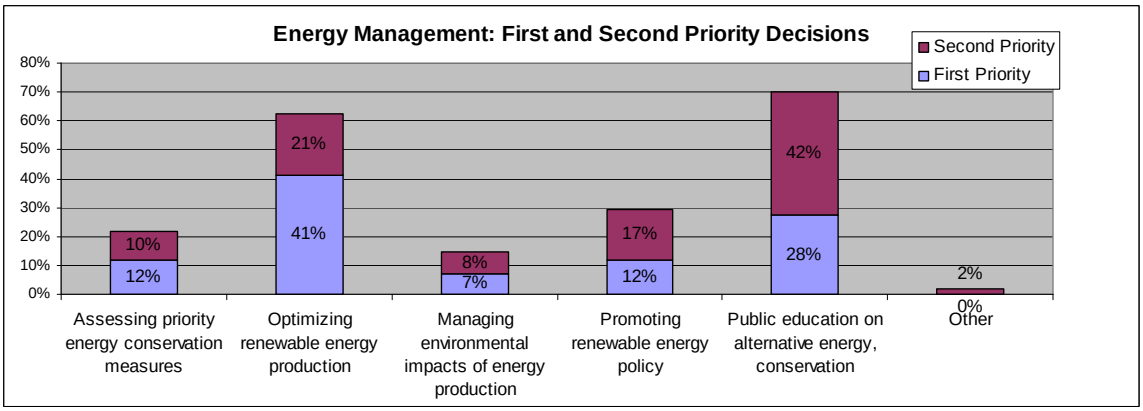

Figure 15. First and second priority energy management decisions

When asked about data and tools used to support the energy management decisions above, the majority cited data and tools other than those listed (83%). Data and tools used to support the specific energy management decisions identified in Figure 16 are discussed below:

- Of the 12 respondents that identified assessing priority energy conservation measures as a priority decision, three (25%) use GIS, while two (17%) use computer modeling. One each (8%) relies on climate data and soil/water data, while four (33%) use some other source of information not listed.
- Of the 35 respondents identifying optimizing renewable energy production as a priority decision, seven (20%) rely on GIS to support decision making; six (17%) use climate data; four (11%) use soil/water data; and 13 (37%) cited "other", with several noting that this is a new area for them and they are just figuring out what they need. Just two (6%) each use decision support tools and computer modeling. One clarified that their priority decision was really predicting water flow at different times of the year to ensure adequate storage necessary for multiple uses of that water, including energy production.

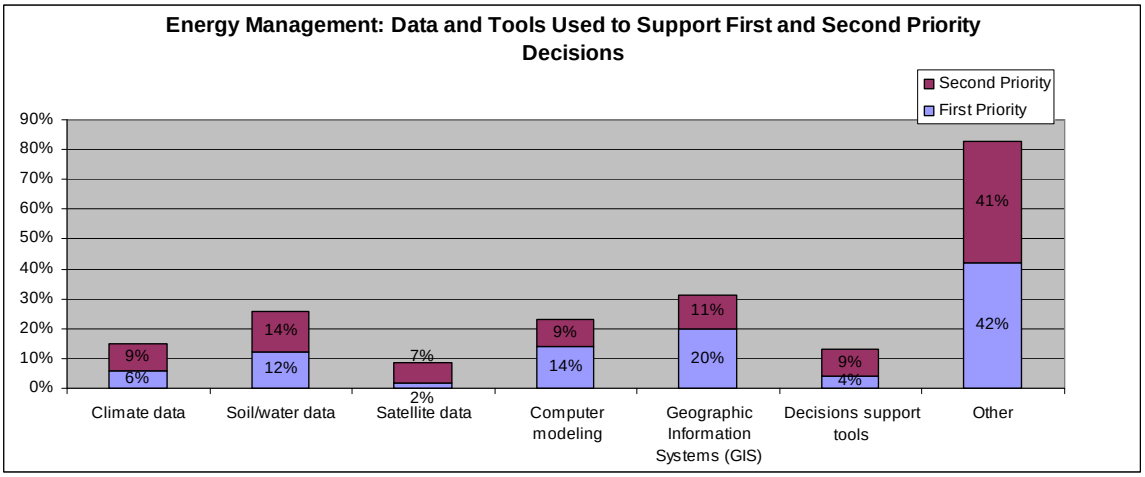

Figure 16. Data and tools used to support priority energy management decisions

- Of the eight respondents that identified managing the environmental impacts of energy production as a priority, four (50%) rely on soil/water data. One (13%) relies on decision support tools and another uses computer modeling.
- Of the 16 respondents identifying promoting renewable energy policy as a priority decision, three (19%) rely on GIS to support decision making; and one each (6%) identified computer modeling, climate data satellite data and soil/water data. Five (31%) indicated that some other form of information not listed was used to support decisions, including wind speed data, weather patterns, and information on economics of renewable energy.
- Of the 38 respondents identifying public education on alternative energy or conservation as a priority decision, five (13%) rely on computer modeling, four (11%) rely on GIS, three (8%) each use soil/water data and decision support systems. Fifteen (39%) indicated that they use some other resource not listed, including experience of utility partners, information available from NRCS, DOE and the State energy offices, information from the media and universities. Eight (21%) did not specify.

As illustrated in Figure 17, only 37% of those surveyed think they have the information they need to make adequate energy management decisions. Of those who elaborated on their needs, six cited the need for feasibility studies on renewable technologies, including wind, solar and biomass. Other individuals pointed to the need for education and training in renewable energy, the need for better streamflow forecasting, and the need for an integrated toolset for energy management that ties together data and modeling efforts for water storage, streamflow, soil moisture, and forest conditions.

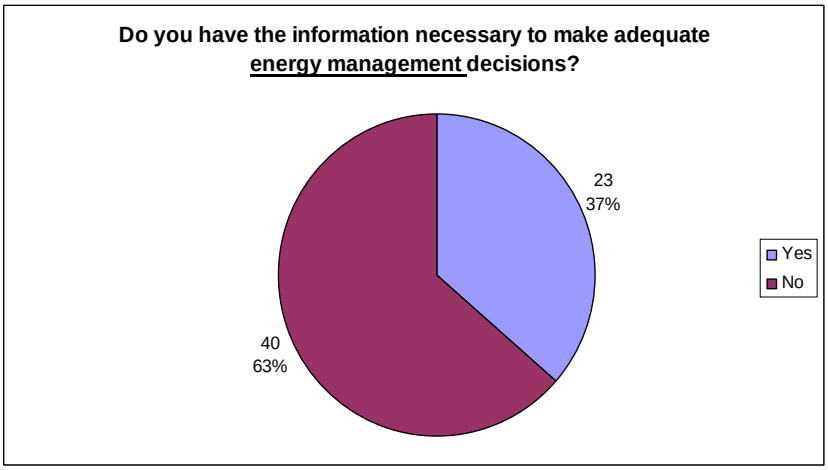

Figure 17. Respondents that have the information necessary to make adequate energy management decisions

2.4 Invasive Species

The top priority management decision related to invasive species was defining strategies to prevent or control noxious or invasive species (55%) (Figure 18). However, evaluating

management actions to control noxious or invasive species was identified by the most respondents identified as either a first or second priority. Predicting where invasive or noxious species are likely to occur was cited as high priority by the fewest respondents.

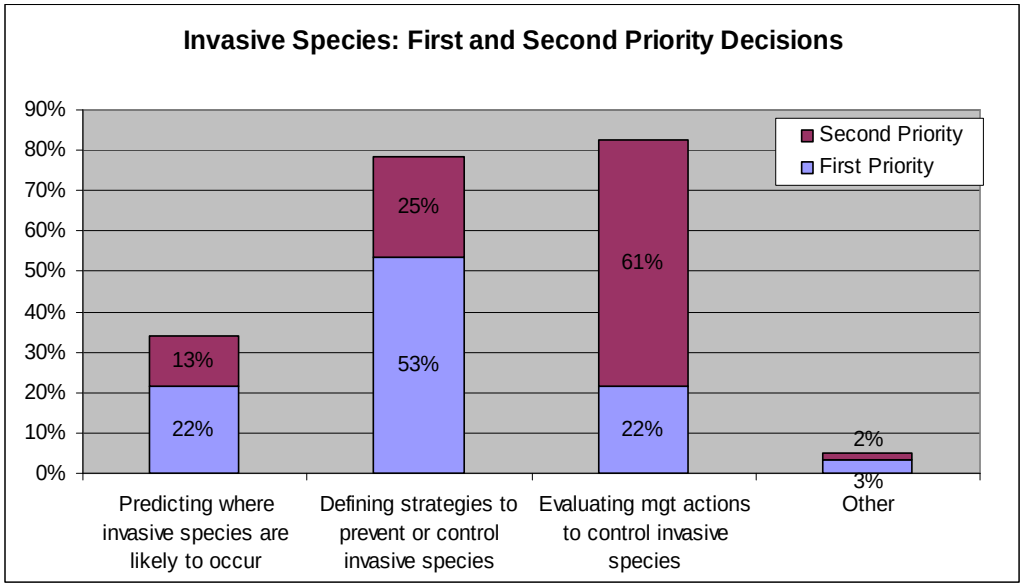

Figure 18. First and second priority invasive species decisions

When asked about data and tools used to support the specific invasive species management decisions above, the majority (70%) rely on vegetation cover data, followed by GIS (34%) (Figure 19). Data and tools used to support each specific invasive species management decisions are discussed below:

- Of the 47 respondents who identified evaluating management actions to control noxious or invasive species as a high priority invasive species decision, 17 (36%) indicated that they rely on vegetation data to support decision making; five (11%) use decision support tools (e.g. Alien Plants Ranking System); four (9%) use GIS; and two (4%) each use satellite data and soil/water data. Fifteen respondents (32%) indicated they use some other type of data or tools not listed or did not specify.
- Of the 46 respondents who identified defining strategies to prevent or control noxious or invasive species a high priority invasive species decision, 16 (35%) indicated that they rely on vegetation data to support decision making; seven (15%) use GIS; six (13%) use soil/water data; four (9%) use decision support tools (e.g. Alien Plants Ranking System); and just one (2%) indicated that they use climate data (e.g. weather, SnoTel, or AgMet stations). Twelve (26%) respondents indicated they use some other type of data or tools not listed or did not specify.
- Of the 20 responses identifying predicting where noxious or invasive species are likely to occur as a priority decision, six (30%) indicated they use GIS to support decision making; soil/water data, vegetation data, and satellite data are each relied on by two (10%) respondents; and just one (5%) uses computer modeling. Seven

(35%) respondents indicated they use some other type of data or tools not listed or did not specify.

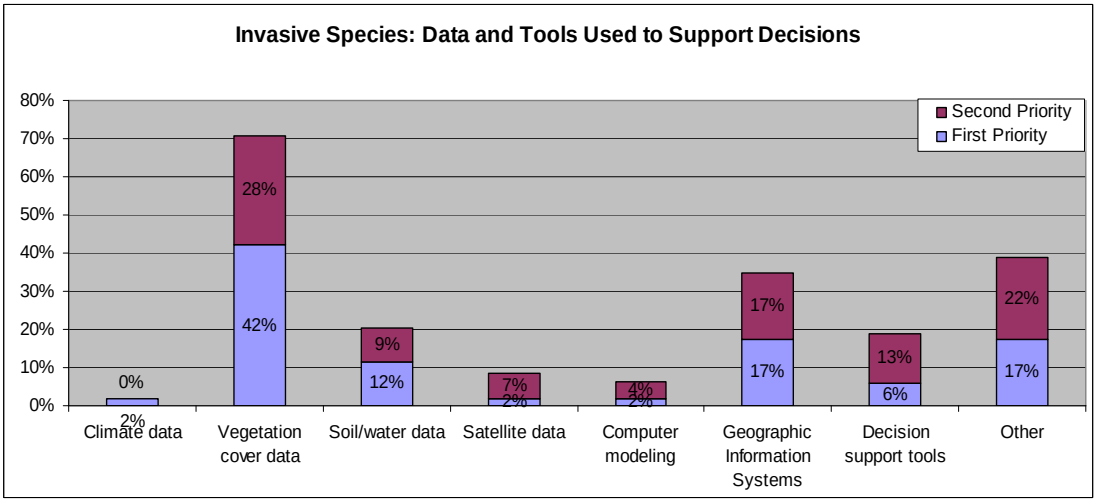

Figure 19. Data and tools used to support priority invasive species decisions

As illustrated in Figure 20, only 31% of those surveyed think they have the information they need to make adequate invasive species management decisions. Six of the individuals who elaborated on additional information needed said mapping of current locations, and in one case historic locations of invasive species, was a priority need, including type of species, density, and location. Another six pointed to the need for tools to predict noxious weed outbreaks and the direction they may move; and one said they need to be able to identify the highest priority areas to target for control and management strategies. A number of respondents cited the need for better remotely sensed imagery.

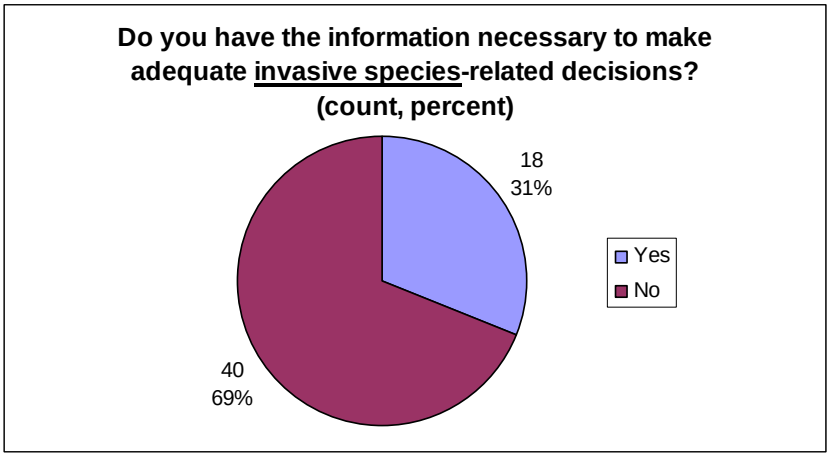

Figure 20. Respondents that have the information necessary to make adequate invasive species management decisions

2.5 Ecological Forecasting

When asked what ecological forecasting decisions the RC&D Councils were most concerned with, a vast majority of survey respondents (81%) identified local/regional land use planning (e.g., development, agriculture, conservation) as either a first or second priority management decision (Figure 21). The next most important ecological forecasting decisions identified – seasonal cover crop planting (e.g., reducing erosion and providing wildlife habitat) (39%) and reducing impacts of and managing for endangered species (27%) – were identified as high priority by significantly fewer respondents. Nine percent of respondents said they have "other" priority ecological forecasting decisions, including assessing the marine environment and predicting long-term precipitation. One RC&D Council that relies on water from a snowpack dominated basin noted than all choices were high priority ecological forecasting decisions.

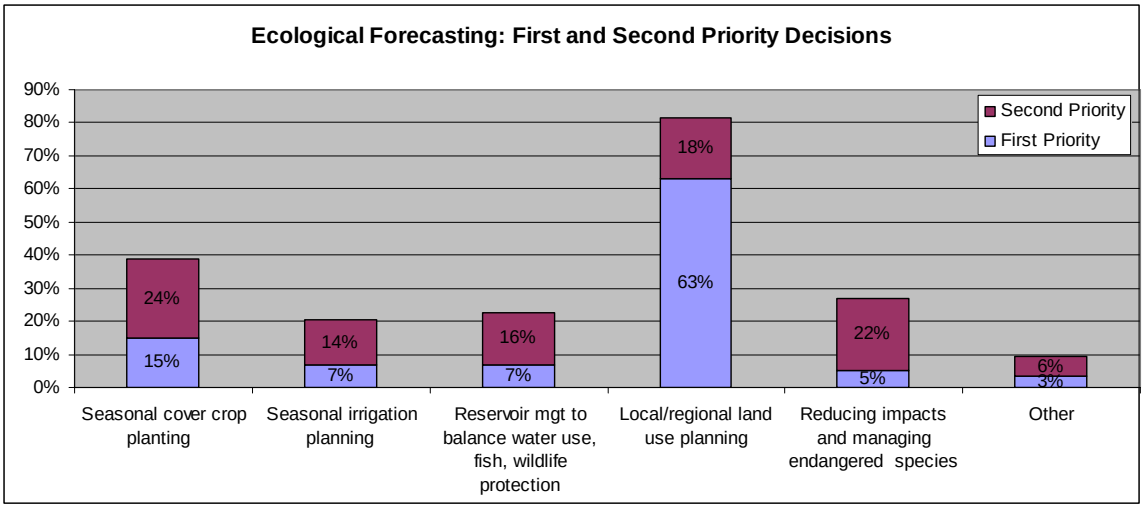

Figure 21. First and second priority ecological forecasting decisions

Regarding the data and tools used to support the specific ecological forecasting decisions cited above, the greatest proportion of responsdents (59%) indicated they use GIS to suport decision making, followed by soil/water data (44%), and computer modeling (24%) (Figure 22). Data and tools used to support the specific ecological forecasting decisions presented are discussed below:

- Of the 47 respondents who identified local and regional land use planning (e.g. development, agricutlure, conservation) as a high priority management decision, 21 (45%) indicated that they use GIS to support decision making; six (13%) use soil/water data; five (11%) use vegetation cover data; four (9%) use computer modeling; one (2%) uses decision support tools (e.g. AgClimate); and one (2%) relies on satellite data. Nine (19%) either indicated they use some other type of data or tools not listed or did not specify.
- Of the 20 respondents who identified seasonal cover crop planting (e.g., reducing erosion and providing wildlife habitat) as a high priority management decision, seven (35%) indicated that they use soil/water data to support decision making; three (15%) use climate data; three (15%) use vegation cover data; two (10%) use

computer modeling; and one (5%) each use vegetation data and decision support tools.

- Of the 12 respondents who identified reservoir management to balance water use with fish and wildlife protection as a high priority management decision, seven (58%) noted that they use soil/water data to support decision making; four (33%) use climate data; three (25%) use soil/water data; three (25%) use computer modeling; and one (8%) each use vegetation data and GIS.
- Of the 11 respondents who identified seasonal irrigation planning (e.g., reducing impacts of irrigation withdrawals) as a high priority management decision, three (27%) each indicated they rely on GIS and soil/water data to support decision making; two (18%) use climate data; one (9%) uses satellite data; and two (18%) did not specify.

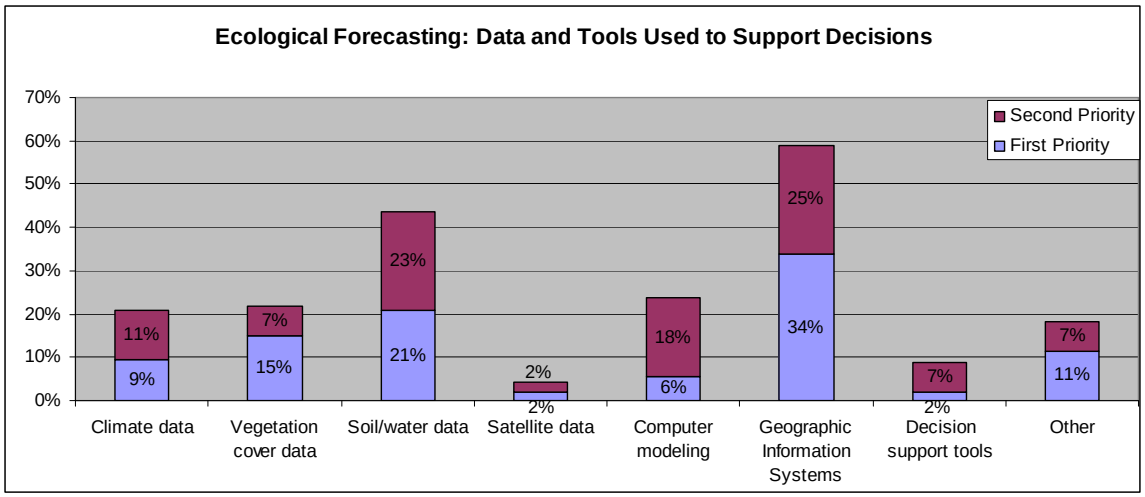

Figure 22. Data and tools used to support priority ecological forecasting decisions

As illustrated in Figure 23, only 31% of those surveyed think they have the information they need to make adequate ecological forecasting decisions. Other information needs cited included: the need for tools to help predict areas vulnerable to wildfire, drought, and flooding; more system-wide water management data including aquifer drawdown and recharge, evaporation rates, DCMI usage; predicted impacts of climate change on precipitation patterns; and tools that link various expected population growth with various competing water uses such as endangered species needs for water and power generation.

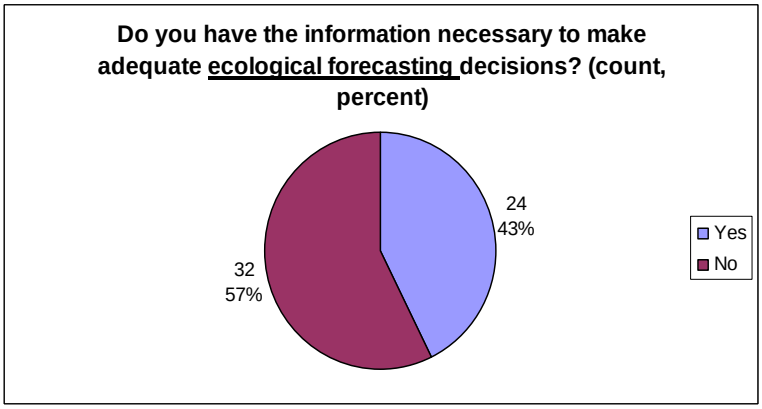

Figure 23. Respondents that have the information necessary to make adequate ecological forecasting decisions

2.6 Climate Change

When asked what climate change decisions the RC&D Councils were most concerned with, the greatest proportion of respondents identified creating economic development opportunities as either the first or second highest priority decisions their RC&D Council members make (47%) (Figure 24). The second most important set of climate change decisions cited by respondents was predicting climate change impacts on agriculture (e.g. crops and grazing) (38%) and predicting impacts on water resources and water quality (33%). Ten percent of respondents that identified their priority climate change decision as "other" decisions not listed, and one noted that their RC&D Council is not directly addressing climate change at this time.

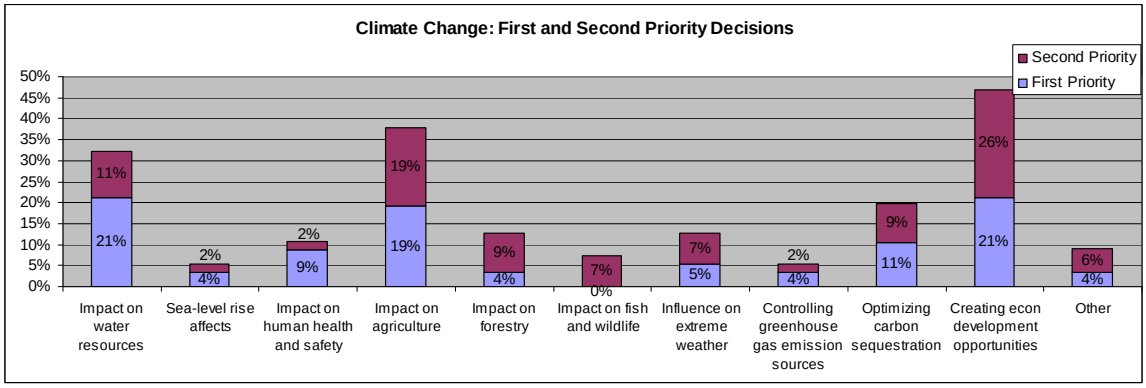

Figure 24. First and second priority climate change decisions

When asked what data and tools the RC&D Councils and their constitutents use to support their priority climate change decisions, the highest proportion of respondents selected “other” from the list of options, perhaps suggesting that very little data and tools are used to support decision making around climate change (Figure 25). Of the options listed, climate data is used by the most RC&D Councils to support decision making. Data

and tools used to support the specific climate change decisions presented are discussed below:

- Of the 26 respondents who identified creating economic development opportunities as a high priority climate change decision, five (19%) indicated they rely on GIS to support decision making; three (12%) use computer modeling; and one (4%) uses climate data (e.g., Weather, SnoTel or AgMet stations). Fifteen (58%) indicated they use some other type of data or tools not listed or did not specify.
- Of the 21 respondents who identified predicting climate change affects on agriculture as a priority climate change decision, five (24%) each indicated they rely on climate data (e.g., Weather, SnoTel or AgMet stations) and and five (24%) rely on soil/water data to support decision making. Two (10%) use computer modeling, and one (5%) each indicated they use satellite data, decision support tools, vegetation cover data, and GIS. Five (24%) did not specify what data or tools, if any, they use to support decision making.
- Of the 18 respondents concerned most with predicting climate change effects on water resources and water quality, climate data was the most commonly cited source of decision support by six (33%) respondents. Four (22%) others cited use of computer modeling, two (11%) rely on soil/water data, one (6%) uses GIS, and one use vegation data. Four (22%) did not specify.
- Of the 11 respondents who cited optimizing biological or geological carbon sequestration as a priority management decision, vegetation cover data was cited by three (27%) as important to support decision making, while two (18%) each cited use of soil/water data and decision support tools (e.g. COMET-VR for carbon management). Just one (9%) relies on climate data (e.g., Weather, SnoTel or AgMet stations) and three (27%) did not specify what data or information they use.
- Of the eight respondents that identified predicting climate change influence on extreme weather (e.g., drought) as a priority climate change management decision, three (38%) use climate data, two (25%) use soil/water data, and one (13%) uses satellite data to support decision making. Two (25%) did not specify.
- Of the six respondents most concerned with predicting climate change affects on human health and safety, climate data was cited by four (67%) respondents as the information they use to support decision making, while just one (17%) said they use decision support tools and one did not specify.
- Of the four individuals that identified predicting climate change affects on forestry as a priority climate change issue, two (50%) each cited the use of GIS and soil/water data to support decision making, one (25%) cited the use of climate data, and just one (25%) uses satellite data.
- Of the four individuals that identified predicting climate change effects on fish and wildlife as a priority climate change issue, one (25%) each cited the use of computer modeling, GIS, and soil/water data to support decision making. Another said simply that they need better information.
- Of the three respondents who identified predicting sea-level rise effects on coastal communities as a high priority climate change-related decision, one (33%) uses

GIS to support decision-making, one uses (33%) computer modeling, and one (33%) did not specify.

- The three respondents who identified controlling greenhouse gas emission sources as a high priority climate change decision, one relies on GIS (33%), one on decision support tools (33%), and one (33%) did not specify.

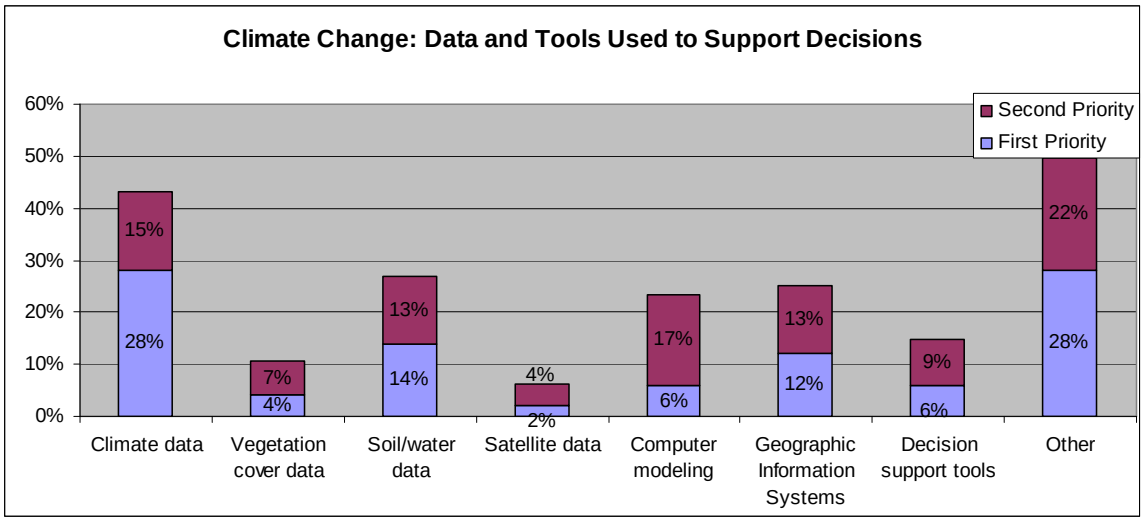

Figure 25. Data and tools used to support priority climate change decisions

As illustrated in Figure 26, only 29% of those surveyed believe they have the information they need to make adequate climate change decisions. Several survey respondents commented that the they have little to no information to support decision-making relative to climate change, but were not able to specify what information they needed. Several commented generally that they need more data and modeling tools. One respondent suggested the need to combine climate modeling tools developed in Canada with satellite-enhanced streamflow predictive models, such as those developed under the NOPSN, and local current snow survey data to evaluate the effects on human populations and water use under different climate change scenarios.

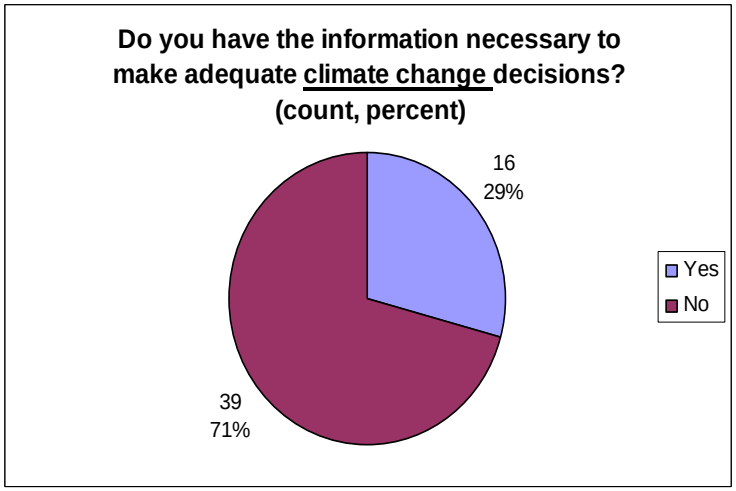

Figure 26. Respondents that have the information necessary to make adequate climate change decisions

2.7 Disaster Management

For decisions related to disaster management, the greatest number of respondents (75%) identified land use planning decisions to manage risk of flood, drought, or wildfire as their first or second priority decision (Figure 27). Predicting and managing areas vulnerable to floods and droughts was the next most common response (45%), followed by predicting and managing areas vulnerable to wildfires (38%). Of the 10 percent who cited "other" disaster management decisions as high priority, respondents identified earthquakes, hurricane readiness, predicting and managing destruction produced by tornadoes, and assisting rural communities with disaster recovery as important decisions they need to make.

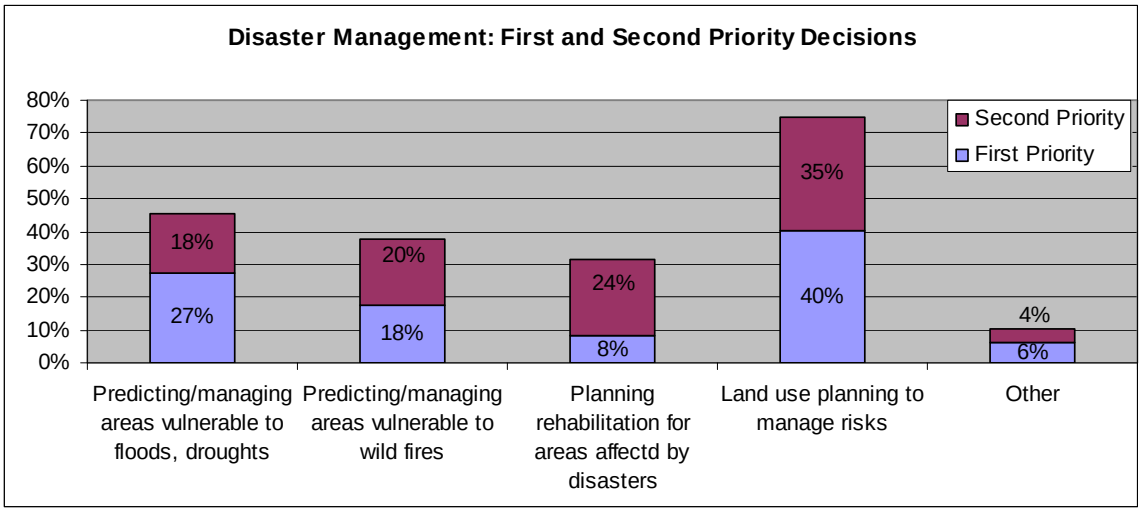

Figure 27. First and second priority disaster management decisions

When asked what data and tools the RC&D Councils and their constituents use to support these decisions, GIS is the most commonly used tool to support disaster management decision-making, cited by 54%, followed by soil/water data (39%), and climate data (30%). Satellite data is used to support those concerned with predicting and managing tornado destruction, and climate data is used to support hurricane readiness (Figure 28). Data and tools used to support specific disaster management decisions listed above are described below:

- Of the 44 respondents who identified land use planning decisions to manage flood, drought, or wildfire risks as a priority disaster management decision, 15 (34%) indicated they most frequently use GIS to support those decisions, followed by eight (18%) who cited topography data/maps, four (9%) who cited computer modeling, three (7%) who use decision support tools (e.g., HEC Flood Damage Analysis, HEC-FDA), and two each that use climate data (5%) and soil/water data (5%). Nine (20%) either indicated they use some other type of data or tools not listed (e.g. based on past experience) or did not specify.
- Of the 27 respondents who identified predicting and managing areas vulnerable to floods and droughts as a priority disaster management decision, six (22%) indicated that they rely on climate data (e.g., weather, SnoTel or AgMet stations)

and six (22%) rely on topography data/maps to support decision making; GIS and soil/water data were each cited by three respondents (11%) as important data or tools to support decisions; and decisions support tools (e.g., HEC Flood Damage Analysis, HEC-FDA) and computer modeling were each cited by two (7%) respondents. Just one (4%) uses satellite data to support decision making. Four (15%) either indicated they use some other type of data or tools not listed or did not specify.

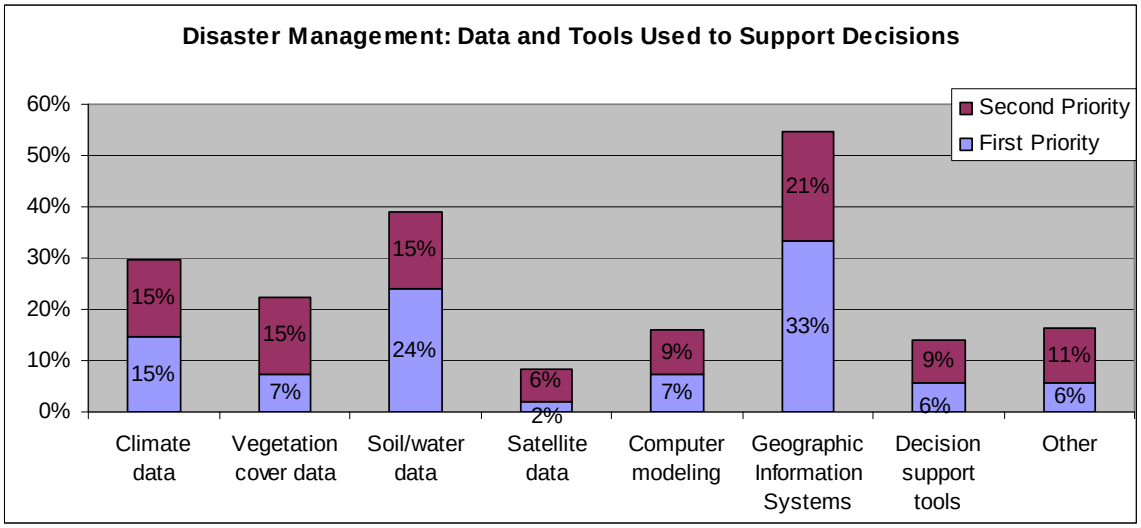

Figure 28. Data and tools used to support priority disaster management decisions

- Of the 22 respondents who identified predicting and managing areas vulnerable to wildfires as a high priority disaster management decision, six (27%) indicated that they rely on GIS to support decision making; five (23%) use climate data (e.g., weather, SnoTel or AgMet stations); four (18%) use topography data/maps; one person each said they use computer modeling (5%), soil/water data (5%), and satellite data (5%). Four (18%) either indicated they use some other type of data or tools not listed or did not specify.
- Of the 18 respondents who identified planning rehabilitation or replanting for areas affected by floods, droughts, or fires as a priority disaster management decision, five (28%) indicated they most frequently use soil/water data to support those decision, followed by three (17%) citing use of GIS, two (11%) citing use of decision support tools, and one each citing the use of computer modeling (6%), satellite data (6%), and topography data/maps (6%). Five (28%) either indicated they use some other type of data or tools not listed (e.g. based on past experience) or did not specify.

As illustrated in Figure 29, only 41% of respondents indicated that they have the information necessary to make adequate disaster management decisions. Those who elaborated on their disaster management information requirements noted the need for: climate change impact analysis as it relates to potential for disasters, including floods and droughts; tools to more accurately predict high and low streamflows, crop failure/growth, and forest health as it relates to wildfires and disaster management; and tools to support

land use planning as it relates to flooding, drought, and wildfire. Two cited the need for more local scale data.

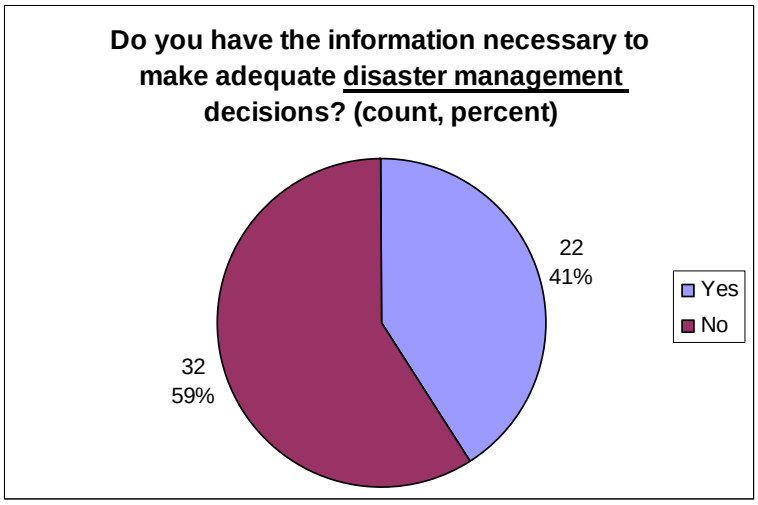

Figure 29. Respondents that have the information necessary to make adequate disaster management decisions

3. Conclusions

A total of 76 RC&D Councils from throughout the country responded to the survey. The highest concentration of survey participants was located in the northeast United States.

The survey results suggest that all of the NASA application areas have some relevance to the RC&D Councils. Water management and energy management had the highest average scores for importance to the RC&D Councils and their constituents. More than half of respondents specifically identified water management as the single most important issue RC&D Councils are dealing with. Those respondents citing water management as their top priority were geographically distributed throughout the country.

The issues considered very important by the fewest respondents were weather forecasting, climate change, disaster management, and coastal management. Other topics, including public health, ecological forecasting, and weather forecasting, scored moderately important but were not identified by anyone as their most important issue.

The RC&D Councils surveyed do not commonly use NASA data and data products, with just over a quarter of respondents indicating that their RC&D Council or the organizations they work with had experience with NASA data. The issue for which satellite data is used most to support decision-making is invasive species management, followed by energy management, disaster management and agriculture efficiency. Satellite data was cited by the fewest as a resource to support water management decisions.

The RC&D Councils provided detailed information on seven of the NASA national application areas thought to be most relevant to the RC&D Councils. For each of these applications, less than half of respondents said they had the information they needed to make adequate decisions about the issue. The issue that the most RC&D Councils indicated they are least prepared to deal with is climate change. Seventy-one percent of respondents said they lacked the information necessary to make adequate decisions related to climate change. The issue that respondents appear to be best positioned to deal with among the seven application areas is water management, although there is still a need for better information as just 46% percent of respondents think they information they have is adequate for decision-making. Interestingly, the majority of those concerned with water management indicated they rely heavily on direct observation or interpersonal communication, rather than more sophisticated tools (e.g. decision support systems and tools) to help make water management decisions.

These findings indicate that RC&D Councils deal with many issues relevant to NASA's national application areas. Most survey respondents feel their Councils do not have adaquate information to address the priorty issues they are facing. Once the barriers to use of NASA satellite data are better understood among RC&D Councils, this could represent a large opportunity for NASA to impact and support decision-making among RC&D Councils and their constituents nationwide.

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Appendix A: Web-based Survey Instrument

The survey instrument is copied below and can also be viewed online at:
http://www.surveymonkey.com/s.aspx?sm=4yAFqdKDTLiiSQFVIsDi5A%3d%3d

National RC&D Evaluation - Phase I Survey

Introduction

NASA is interested in working with the Resource, Conservation, and Development (RC&D) Councils to develop improved, science-based approaches to resource management decision-making using NASA data and tools. During 2007-2008, a pilot application of an improved water management tool using NASA data is being completed in the North Olympic Peninsula (NOP) RC&D area. During 2008-09, the tools developed for the NOP RC&D will be demonstrated in four other locations in the U.S.

The purpose of this survey is to:

1. help NASA understand priority decisions the RC&D constituents make and what information they use to make them, and;

2. help identify four RC&Ds that could benefit from the water management tools developed under this project.

This survey should take approximately 15 minutes to complete.

1. What is the importance of each issue below to the area your RC&D Council serves? Rate each on a scale of 1 to 7, where 1 is "not important" and 7 is "very important." Definitions are provided below.

	1 (Not Important)	2	3	4	5	6	7 (Very Important)
Water Management	. Water Management 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Agricultural Efficiency	Agricultural Efficiency 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Ecological Forecasting	Ecological Forecasting 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Air Quality	Air Quality 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Disaster Management	Disaster Management 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Public Health	Public Health	2	3	4	5	6	7 (Very

	1 (Not Important)	2	3	4	5	6	7 (Very Important)
	1 (Not Important)						Important)
Carbon Management	Carbon Management 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Invasive Species	Invasive Species 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Coastal Management	Coastal Management 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Energy Management	Energy Management 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Climate Change	Climate Change 1 (Not Important)	2	3	4	5	6	7 (Very Important)
Weather Forecasting	Weather Forecasting 1 (Not Important)	2	3	4	5	6	7 (Very Important)

DEFINITIONS (Please scroll down for question 2)

Water Management - Monitoring water quality and identifying the location and magnitude of existing and potential pollution sources and impacts to ensure adequate water supply.

Agricultural Efficiency - Having reliable weather and climate predictions and observations to support local and regional decision-making around agriculture management.

Ecological Forecasting - Predicting the impacts of environmental changes on local and regional ecosystems.

Air Quality - Information to support development of policies and practices associated with air quality standards and evaluation of emission control strategies.

Disaster Management - Decision support for disaster impact assessments, risk communication, mitigation, and implementation of relief efforts.

Public Health - Understanding how weather, climate, and other key environmental factors may influence chronic and infectious diseases.

Carbon Management - Understanding and measuring how land management practices can enhance carbon sinks.

Invasive Species - Predicting invasive species spread and distribution.

Coastal Management - Understanding the impact of human activities (e.g. nutrient concentrations) on coastal ecosystems.

Energy Management - Decision support on the use of renewable and non-renewable resources needed to generate energy.

Climate Change - Understanding climatic change over seasonal, interannual, decadal, and

longer time periods.

Weather Forecasting - Having more accurate and extended weather forecasts for daily decisions.

2. Which of these 12 issues is the single most important to the area your RC&D Council serves? (Please select only one answer.)

Which of these 12 issues is the single most important to the area your RC&D Council serves? (Please select only one answer.) Water Management

Agricultural Efficiency

Ecological Forecasting

Air Quality

Disaster Management

Public Health

Carbon Management

Invasive Species

Coastal Management

Energy Management

Climate Change

Weather Forecasting

3. Do you or the organizations you work with have any experience with NASA data and/or products?

Do you or the organizations you work with have any experience with NASA data and/or products? Yes

No

4. Which of the following types of groups does your RC&D Council work with most to achieve its resource management goals? Check all that apply.

Academic/research institutions

Local governments

State or federal governments

Regional planning groups

Watershed planning groups

Irrigation districts

Tribes

Other (please specify)

For each of the next seven questions, identify two priority resource management decisions your collaborators have to make, and the data and tools used to help make those decisions. Choose an option from the drop down menu or select "other" and explain.

5. What are the first and second priority Water Management decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority water management decision:

First Priority:	
Second Priority:	

Data and tools used to support that decision:

First priority:	
Second priority:	

Other

6. Do you have the information necessary to make adequate decisions?

Yes

No

If no, please explain what information would help you make better decisions:

7. What are the first and second priority Agriculture Efficiency decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority agriculture efficiency decision:

First Priority:	Managing pesticide or nutrient use
Second Priority:	

Data and tools used to support that decision:

First Priority:	Soil/water data

Second Priority:	

Other

8. Do you have the information necessary to make adequate decisions?

Yes

No

If no, please explain what information would help you make better decisions:

9. What are the first and second priority Energy Management decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority energy management decision:

First Priority:	
Second Priority:	

Data and tools used to support that decision:

First Priority:	
Second Priority:	

Other

10. Do you have the information necessary to make adequate decisions?

Yes

No

If no, please explain what information would help you make better

decisions: 

11. What are the first and second priority Invasive Species-related decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority invasive species-related decision:

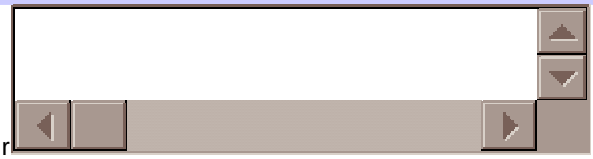
First Priority:

Second Priority:

Data and tools used to support that decision:

First Priority:

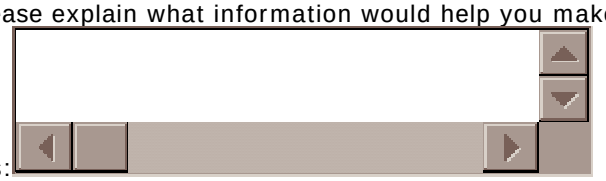
Second Priority:

Other 

12. Do you have the information necessary to make adequate decisions?

☐ Yes

☐ No

If no, please explain what information would help you make better decisions: 

13. What are the first and second priority Ecological Forecasting decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority ecological forecasting decision:

First Priority:

:

Second Priority:

Data and tools used to support that decision:

First

Priority:	:
Second Priority:	

Other

14. Do you have the information necessary to make adequate decisions?

Yes

No

If no, please explain what information would help you make better decisions:

15. What are the first and second priority Climate Change decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

Priority climate change decision:

First Priority:	
Second Priority:	

Data and tools used to support that decision:

First Priority:	
Second Priority:	

Other

16. Do you have the information necessary to make adequate decisions?

Yes

No

If no, please explain what information would help you make better

decisions: 

17. What are the first and second priority Disaster Management decisions addressed by your Council's constituents/collaborators, and what data and tools are currently used to support that priority decision?

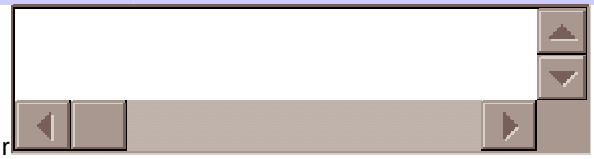
Priority disaster management decision:

First Priority:	
Second Priority:	

:

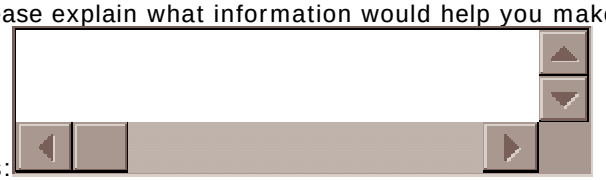
Data and tools used to support that decision:

First Priority:	
Second Priority:	

Other 

18. Do you have the information necessary to make adequate decisions?

- Yes
- No

If no, please explain what information would help you make better decisions: 

19. Please enter your contact information below. This is for follow-up purposes only. We will not release your personal information to others.

(Please note that a zip/postal code is required on this page.)

Name:	
Organization:	
Address:	
Address 2:	

City/Town:	
State:	-- select state --
*** ZIP/Postal Code:**	
Country:	
Email Address:	
Phone Number:	

20. Would you like to get a copy of the summary results?

Would you like to get a copy of the summary results? Yes

No

Appendix B: How NASA Activities Can Benefit RC&D Council Members

The National Aeronautical and Space Administration's (NASA's) Earth Science Program is designed to help develop a better scientific understanding of the earth and how it responds to both human and environmentally induced changes. NASA utilizes satellites, aerial platforms and models to view the earth and its processes and to measure and predict changes. NASA's Applied Science Program harnesses large quantities of NASA data and information and provides it to various institutions and the public, thereby allowing us to better understand and mange these processes and changes. This program is currently focused on providing data and information in the six priority areas below.

- **Agricultural Efficiency** - NASA works with the U.S. Department of Agriculture (USDA) and the National Oceanic and Atmospheric Administration (NOAA) to better understand seasonal climate variability and to evaluate critical agricultural parameters such as crop production, water availability, solar radiation, and vegetation health over large areas. It also teams with the USDA's Foreign Agricultural Service and the National Agricultural Statistics Service to provide space-based data for modeling, monitoring and forecasting global and domestic agricultural production. In addition, many plant and animal diseases are related to climate and environmental conditions. For example, the establishment and/or migration of agricultural pests are often linked to climate variables, such as temperature and moisture, and environmental variables, such as the location of water bodies, the presence of vegetation and soil moisture. NASA satellite data and models can be utilized to evaluate the likely occurrence or migration of vectors such as ticks and mosquitoes, which can transport animal diseases, and wind, rain or other vectors which can transport plant pathogens.

- **Water Management** – NASA works with many agencies, including the U.S. Department of Interior's Bureau of Reclamation (BOR), the Environmental Protection Agency (EPA) and the USDA to determine where supplies of fresh water are located, to quantify how much water is available, and to figure out how fast water supplies are increasing or decreasing. Increased water use and climate changes threaten to deplete and/or modify the quality, quantity, timing and location of these precious water resources. Therefore, accurate information is needed to support decision-making that meets the needs of both humans and the environment. NASA satellite data can help to improve our understanding of evaporation, refine our ability to track changes in surface soil moisture, monitor aquifer water storage changes from space, and track water quality changes over time. Incorporating all of this information into decision support systems will lead to improved capability to predict water availability, protect water quality, and plan for water conservation.

- **Public Health** – NASA satellite data and models help predict and track conditions that may support and or cause the migration of diseases and disease vectors. Like agricultural diseases, many chronic and infectious human diseases (e.g. West Nile

virus) are related to climate and environmental conditions. Vectors such as ticks and mosquitoes transport human pathogens. Variability in rainfall and temperature has a major influence on the distribution and quantity of both pests and diseases. In addition, high concentrations of atmospheric pollutants can worsen respiratory diseases such as asthma and emphysema. NASA's goal is to help determine how weather, climate, and other key environmental factors, such as vegetation, forests, flooding, wetlands, soil moisture, surface ultraviolet radiation, and surface temperatures correlate with the occurrence of chronic and infectious diseases.

- **Disaster Management** - NASA works collaboratively with the Federal Emergency Management Agency (FEMA), NOAA, the USDA, and the U.S. Geological Survey (USGS) to provide data to support FEMA decision support systems that are utilized by planners, early warning systems and first responders. NASA data contribute to disaster forecasting, impact assessments, risk communication, disaster mitigation, and implementation of relief efforts related to wildfires, hurricanes and tornados, floods and other weather-related disasters.

- **Ecological Forecasting** – NASA utilizes satellite data and models to forecast the impact of environmental changes on local and regional ecosystems. These forecasts help us manage and preserve essential ecosystem services such as clean air, fresh water, fertile soils, waste removal, and biodiversity while building and maintaining our agricultural economies. Satellite imagery combined with other data in geographic information systems is used to generate visualization products for decision-makers. With this information, decision-makers can detect and evaluate such things as wild fires and major changes in land cover, track rainfall and weather patterns, and monitor coastal margins and coral reefs. NASA models help us understand the poorly understood connection between changes in land cover and climate variation.

- **Air Quality** - NASA is working with the EPA to help better fulfill its air quality management responsibilities and to make air quality forecasts. NASA utilizes atmospheric chemistry and dynamics models and satellite data to conduct air quality studies related to ozone mapping and transport, and pollutants like sulfur dioxide, particulate matter (aerosols), carbon monoxide, and methane. It is also utilizing satellite data to study the chemistry of our atmosphere, and key atmospheric constituents and how these constituents change over time.

Each of these areas has some relevance to agriculture and Resource Conservation and Development Councils in the United States. Which areas are most relevant to an individual or organization will depend on the specific location, activities, issues and needs of a particular individual or organization. However, it is NASA’s desire to make its data and tools accessible to all individuals and organizations who can utilize them to better understand and manage their natural resources and protect the environment. Additional information on each of these and other NASA Applied Sciences priority areas can be found at: http://science.hq.nasa.gov/earth-sun/applications/.