V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Excellence in Water and Watersheds: Advance understanding and effective management of water, wate

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources			14%	
102	Soil, Plant, Water, Nutrient Relationships			10%	
111	Conservation and Efficient Use of Water			14%	
112	Watershed Protection and Management			10%	
132	Weather and Climate			12%	
133	Pollution Prevention and Mitigation			10%	
403	Waste Disposal, Recycling, and Reuse			10%	
404	Instrumentation and Control Systems			10%	
405	Drainage and Irrigation Systems and Facilities			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid Professional	0.0	0.0	20.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	100285	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	788208	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	1984371	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research is often carried out at field sites which are related to a specific project. Field sites with short- and long-term instrument deployment are located in all four corners of Oregon, as well as Washington State, Kansas and Canada.

We will develop and use novel soil-water instrumentation. Passive measurement of spatially distributed soil temperature can allow for estimation of the energy consumption of evapotranspiration and soil water flux. Beyond passive reporting of temperature, the use of actively heated fiber optics for the observation of subsurface water movement and water content via a heat pulse offer new research opportunities. Continuous temporal and spatial measurement at various scales will be validated and incorporated into new models and measurement tools. Improved spatial statistics is an aspect affecting remote sensing experiments and measurements, particularly related to soil moisture.

We will update and expand the reference evapotranspiration data currently available for Oregon. We expect to develop references for short and tall crops, disease and weed free, shaded and not short of water scenarios. We will compare estimates to recently available data form AGRIMET stations to validate estimating methods. We will consolidate meteorological data and develop a database in support of this effort. Information will be used to update Extension publications (both hard copy and online) to allow better information accessibility and wider range of applications. The effort is also applicable for long term agricultural and water resources planning.

Technological advances have made possible the development of a hydrologic model capable of simulating the interactions and processes between surface water and groundwater. Results of model simulation will help in the decision making process by producing a water budget analysis and an easy visualization of several management scenarios, e.g., no surface recharge from the irrigation canals.

Field observations of physical and biological processes and functions, benthic macroinvertebrate community, numerical and statistical models play critical roles in understanding the driving principles of watershed and river ecosystems and linkages. In addition, the use of laboratory flumes for simulating sediment and channel changes are a "safe" and controlled way to experiment with or predict outcomes of river management activities.

Watershed and river basin scale resource simulation models and decision tools will be used to examine coupled natural and human systems and trajectories of change under alternative future scenarios.

- Conduct Research Experiments.

- Monitor and evaluate

- Conduct Workshops, meetings.

- Deliver Services.

- Develop Products, Curriculum, Resources.

- Provide Training.

- Assessments.

- Partnering.

2. Brief description of the target audience

The audience includes typical citizens in urban settings through extension outreach, those responsible for agricultural production through extension outreach and workshops, the engineering profession through publication of results in professional journals, and undergraduate and graduate students through presentation of project descriptions and results in a classroom setting.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2012
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	2	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY: Indicator Type 1...Document natural processes and responses to anthropogenitically-influenced conditions: a) Understand feedbacks between plants, soil hydraulic processes and atmospheric boundary layer development - Selker b) Evaluate dynamics and variability in fish and benthic macroinvertebrate communities - Tullos c) Investigate biotic-abiotic interactions and responses to disturbance in aquatic environments, both historically and in response to events or management - Tullos

Year	Actual
2012	0

Output #2

Output Measure

- EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY: Indicator - Type 2...Develop instrumentation and apply instrumentation systems (monitor, survey, collect data) to test hypotheses and events: a) Monitor soil moisture content and soil hydraulic properties at various scales related to 1) landscape subsurface hydrology 2) snow accumulation and ablation 3) upscaling from point to pixel - Selker; b) Monitor response to dam removal - Tullos

Year	Actual
2012	0

Output #3

Output Measure

- EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY: Indicators - Type 3....Develop models and reference data: (soil) a) Evaluate predictive power soil moisture and soil hydraulic models - Selker b) Evaluate evapotranspiration estimating methods for state-wide water resource management - Cuenca

Year	Actual
2012	0

Output #4

Output Measure

- EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY: Indicators - Type 3b....Develop models and reference data: (steams/rivers) c) Investigate aquifer recharge project design to enhance stream habitat and increase available water resources, examine management scenarios (5) Cuenca and Selker d) Investigate biotic-abiotic interactions and responses to disturbance in aquatic environments relative to river management strategies (5) - Tullos

Year	Actual

2012	0

Output #5

Output Measure

- EFFECTS ON AND PROTECTION OF ENVIRONMENTAL HEALTH AND ECOLOGY: Indicators - Type 3c....Develop models and reference data: (watershed) e) Examine coupled natural and human systems through watershed scale and river basin scale water resource simulation models and decision tools (whole system, vegetation, ecosystem services models) - Bolte and Cuenca f) Understand human elements in natural resources management (human surveys, analyses of landscape actors and social institutions) and conduct multiagent and adaptive management modeling - Bolte and Cuenca

Year	Actual
2012	0

Output #6

Output Measure

- OTHER SCHOLARLY EXCELLENCE: participation on professional boards and committees, as well as science panels, and receipt of awards

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Knowledge Indicators - Type 1...People provided information: - Informed decision-makers and citizenry - Better informed extension faculty - Better informed watershed councils and irrigation managers - Better informed agricultural producers - Trained scholars and peers
2	Knowledge Indicators - Type 2a - better understanding about water resource systems (and soil) * interconnectivity of soil and water resources
3	Knowledge Indicators - Type 3 Better tools and models, e.g., flumes, continuous data probes, revised models, coupled models
4	Action/Application Indicators - Type 1 Decision-makers use resource allocation or management tools e.g., Revised Oregon Irrigation Water Requirements Guide, websites
5	Action/Application Indicators - Type 2 Improved irrigation water management
6	Condition Indicators - Type 1 - Environmental a) Improved water availability and quality b) Improved watershed hydrology
7	Knowledge Indicators - Type 2b - better understanding about water resource systems (organisms) * aquatic species habitat and survival,
8	Knowledge Indicators - Type 2c - better understanding about water resource systems (management) * effects of management strategies

Outcome #1

1. Outcome Measures

Knowledge Indicators - Type 1...People provided information: - Informed decision-makers and citizenry - Better informed extension faculty - Better informed watershed councils and irrigation managers - Better informed agricultural producers - Trained scholars and peers

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change, population growth, and economic growth is expected to alter the availability and the use of water in the Willamette River Basin.

What has been done
Drs. Bolte and Tullos have collaborated with other researchers on a comprehensive, highly integrated examination of hydrological, ecological, and socio-economic factors in the Willamette River Basin. The team is applying Envision, a theoretical framework developed at OSU by Dr. Bolte. Envision integrates a geographic information system that manages data in space and time and a computing environment in which state-of-the-art hydrological, ecological, and socio-economic models can interact synergistically. Envision also contains a multi-agent-based modeling component that enables it to represent the impact of human decision-making on landscape change and visualize alternative future scenarios and data sets.

Results
This project is identifying and quantifying the linkages and feedbacks among hydrologic, ecological, and socioeconomic dimensions of the water system to determine where and when human activities and climate change will create water scarcities. The team is working with public officials to help them translate research results into planning and decision making processes. In outyears, the team will transfer tools to other basins, will work with the UNESCO-IHE Institute for Water Education, to transfer Envision to researchers in the UNESCO HELP basins, with a focus on the Blue Nile in Ethiopia.

4. Associated Knowledge Areas

KA Code	Knowledge Area

101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #2

1. Outcome Measures

Knowledge Indicators - Type 2a - better understanding about water resource systems (and soil) * interconnectivity of soil and water resources

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	20000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The lack of continuous data on the spatial structure of soil water distribution is recognized as a key impediment to advancement of hydrologic science.

What has been done
To investigate or monitoring complex agro-hydrologic systems we have developed an entirely new line of methods based on fiber optic temperature sensing. Using this method we can measure temperature, soil moisture, soil water flux, groundwater upwelling in streams and atmospheric turbulence at spatial resolution of 25 cm along transects of up to 2,500m, resulting in up to 10,000 simultaneous measurements. We are also developing wireless networked sensors which can report all micro-meteorological parameters, soil moisture, and other sensor readings (e.g., load cells).

Results
Employing our fiber optic temperature sensing technology in our NASA project, we are conducting large-scale monitoring of soil moisture at about 20,000 locations, simultaneously, to compare ground-truth measurements with remotely sensed values (from aircraft and satellites).

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #3

1. Outcome Measures

Knowledge Indicators - Type 3 Better tools and models, e.g., flumes, continuous data probes, revised models, coupled models

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Given the uncertainty associated with changing availability of water resources, critical questions remain regarding the effects of on the environment and our ability to limit and mitigate those effects. It is critical to identify the major resource constraint issues and to provide water resource management decision-makers with the best scientific information available for addressing the allocation, management and engineering of soil and water resources.

What has been done
Using fiber optic temperature measurement, and other technologies, we are monitoring the response of this complex river system to extensive restoration efforts undertaken by the Warm Springs tribe, the Bureau of Reclamation, The Nature Conservancy, and many private stake holders. This 10-year NOAA funded project is a collaboration between OSU, University of Oregon, Oregon Department of Fisheries and Wildlife, The Warm Springs Tribe, the Middle Fork John Day Watershed Council, and the Bureau of Reclamation.

Results

Through this 10-year case study of the Middle Fork of the John Day River, we are increasing our understanding of the impact of extensive river restoration on ecological function.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
133	Pollution Prevention and Mitigation
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #4

1. Outcome Measures

Action/Application Indicators - Type 1 Decision-makers use resource allocation or management tools e.g., Revised Oregon Irrigation Water Requirements Guide, websites

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change is expected to alter flooding and water scarcity occurences and patterns.

What has been done
Research by Drs Tullos and Bolte included selection of rainfall runoff models for simulated climate change responses, Bayesian uncertainty analysis to characterize sources and features of uncertainty in climate change analysis, and projections in the frequencies of floods and rain-on-snow events in the Santiam River basin and American River, California. Work included coding reservoir operations model for implementation, developing metrics for performance evaluation, and planning reservoir operations analysis within the broader Willamette Water 2100 project. They synthesized literature on the concept of "flexibility" and developed a framework for its operationalization in water resources management.

Results
Results suggest that the largest floods are likely to decrease in frequency while smaller floods are likely to increase in frequency. Their basin scale work will lead to better understanding on how to sustainably manage reservoirs under the future climate scenarios. Metrics developed were applied to the Central Valley Flood Protection Plan, California, and presented at the Floodrisk 2012 Conference, The Netherlands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #5

1. Outcome Measures

Action/Application Indicators - Type 2 Improved irrigation water management

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NASA, National Academy of Sciences and aerospace industries are working to implement a sustained land imaging program which would use remote sensing systems for natural and agricultural water resource evaluation.

What has been done
Dr. Cuenca is part of the NASA AirMOSS project, a group working on the application of remote sensing, i.e. Landsat satellite data, to evaluate evapotranspiration (ET) and crop water use. This work evolves from work done to evaluate ET for irrigated and unirrigated sites in the Wood River Basin, Oregon, using Landsat data. Activities have included a field site visit to the Tropical ? Wet

site at La Selva, Costa Rica, seminars at University of Costa Rica, San Jose, soil profile data analysis from sites at Harvard Forest, Duke Forest, BERMS Old Jack Pine site in Saskatchewan, Canada, Tonzi Ranch, California (UC Berkeley), Metolius site near Sisters, OR and coordination of data submission from two USDA sites at Walnut Gulch, AZ and the MOISST site in OK.

Results
The installation for the Tropical-Dry site at Chamela Biological Research station, Jalisco state, Mexico, was just completed in Feb. 2013.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #6

1. Outcome Measures

Condition Indicators - Type 1 - Environmental a) Improved water availability and quality b) Improved watershed hydrology

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Knowledge Indicators - Type 2b - better understanding about water resource systems (organisms) * aquatic species habitat and survival,

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Efforts to manage natural resources encounter challenges, such as a changing climate and higher demand for extraction. Management structures are almost necessarily based on a limited understanding of what particular species require to successfully live, grow, and reproduce, due, in part, to the extensive time and resources needed to gather sufficient information. This project examines the life history of certain individual species to advance ecological and evolutionary understanding of how particular species of survive.

What has been done

Ocean conditions during early marine residence influence the survival of Pacific salmon, but the mechanisms regulating survival remain poorly understood, as is the relative and potentially interactive effects of freshwater and marine residence on overall survival. Field studies, genetic stock identification, and analytical chemistry generated novel information on important stocks of Chinook salmon in Central Valley, California and in the Columbia River. Quantifying the relative contribution to the adult population of juveniles with distinct migratory behaviors, we found that size at and timing of marine entry were not important although very early marine growth was critical to overall survival; growth during initial marine residence is critical for spring Chinook salmon survival. Ocean conditions may mediate the negative effects of poor freshwater rearing in some years, and should not be ignored.

Results

The Central Valley research led to an improved understanding of how juveniles interact with the freshwater and delta systems and demonstrated the small, yet consistent, contribution of naturally-produced individuals in this species of concern under the Endangered Species Act (ESA). We demonstrated that management actions, which are focused on survival of the hatchery-produced populations, may be inadequate for the maintenance of the diversity of naturally-occurring migratory behaviors. The Columbia River research also focused on populations that are listed under the ESA; a synthesis document on the Columbia River salmon research was prepared in 2012 and is currently being used to evaluate the future intersection between ocean science and salmon management on the Columbia River. Overall, this type of research allows decisions to be based on empirical evidence that will contribute to the management of salmon populations and hydropower systems as well as habitat restoration efforts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
132	Weather and Climate
404	Instrumentation and Control Systems

Outcome #8

1. Outcome Measures

Knowledge Indicators - Type 2c - better understanding about water resource systems (management) * effects of management strategies

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Rangeland vegetation is impacted by limited sources of surface water and groundwater, particularly in shallow aquifer areas. There are questions about the impact on vegetation relative to use of groundwater and fluctuations in precipitation due to climate change.

What has been done
A study of groundwater use by phreatophytic rangeland vegetation in shallow aquifer areas was conducted in the Los Angeles metropolitan area. Efforts addressed the ecophysiology of plants under variable regimes of surface water and gorundwater in order to provide guidelines for groundwater management in areas of limited water resources.

Results
Results of the study demonstrated that water-use efficiency, water allocation, and biomass production was variable among species, but that shrubs are better adapted to water table fluctuations than more shallow-rooted herbaceous species. If climate change results in more summer precipitation, the advantage is likely to shift to herbaceous species. Los Angeles Department of Water and Power is using the information from the study to adjust management of ground water discharge to minimize negative impacts to Ownes Valley ecosystems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate

404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Formative evaluation is still ongoing.

Key Items of Evaluation