

# International Cooperative Development of Techniques for Sustainability when Managing and Restoring Degraded Rangelands

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## Introduction

- ❖ In the United States 20% of privately owned rangelands are vulnerable to accelerated soil loss. Estimated annual costs of direct and indirect damage caused by soil erosion in the United States is \$27 billion dollars.
- ❖ More than 50% of Asia and 70% of Middle Eastern rangelands are degraded. Exact estimates of economic costs and total area degraded is unknown; however, costs may be significantly higher than in the United States due to the extent of degradation/desertification in these regions.
- ❖ United States Department of Agriculture (USDA) scientists and its partners are working with Kazakh National Agrarian University in Kazakhstan and the International Center for Agricultural Research in Dry Areas (ICARDA), Jordan to develop a multiphase approach to validate and deploy various rangeland assessment technologies to address rangeland degradation/desertification by soil erosion and enhance food and water security.

## Rangeland Assessment Tools

- ❖ Rangeland Hydrology and Erosion Model (RHEM) is designed for government agencies, land managers and conservationists who need sound, science-based technology to model and predict runoff and erosion rates on rangelands and to assist in evaluating rangeland conservation.
- ❖ Indicators of Rangeland Health
- ❖ Rangeland National Resources Inventory for monitoring rangelands
- ❖ Agricultural, Runoff, Erosion, and Salinity (ARES) rainfall simulation database can be used to assist in developing model inputs and validating model output to assess soil health and sustainability of site based on erosion rates.
- ❖ Assessing restoration technology (e.g. Vallerani plow for watershed restoration)

Ongoing field research with rainfall simulator, assessment and development of watersheds restoration techniques, and ranch planning are being initiated in the western United States (A), Jordan (B), and Kazakhstan (C) to enhance technologies for ensuring rangeland sustainability.



A) Research on soil erosion assessment and salt transport in western USA



B) Teaching watershed restoration and erosion control techniques in Amman, Jordan



C) Teaching ranch management and rangeland assessment classes in Kazakhstan

## RHEM Webb Tool

## Rangeland Hydrology and Erosion Model

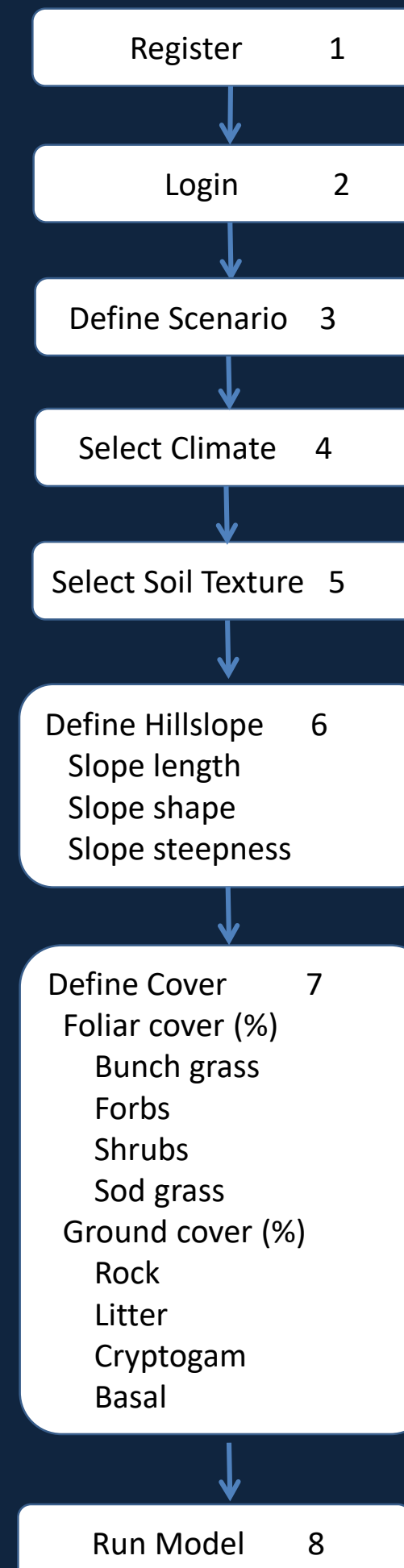
### Model Characteristics

- RHEM is developed specifically for rangeland applications, based on fundamentals of infiltration, hydrology, plant science, hydraulics, and erosion mechanics. It adopts a new splash and sheet erosion equation developed from rangeland soils.
- RHEM models splash erosion and thin sheet-flow transport as the dominant set of processes on undisturbed rangeland sites. For representing erosion on sites with significant disturbances, the model has the capacity to combine splash and sheet erosion with concentrated flow erosion based on the degree of system disturbance.
- RHEM parameterizes hydraulic and erodibility coefficients for different plant groups based on vegetation cover and soil properties.

### Capabilities

- RHEM estimates runoff, erosion, and sediment delivery rates and volumes at the spatial scale of the hillslope and the temporal scale of a single rainfall event.
- RHEM is free web based tool ([dss.tucson.ars.ag.gov/rhem/](http://dss.tucson.ars.ag.gov/rhem/)). RHEM has been embedded within other assessment tools that works at larger scales, such as KINEROS2, APEX or SWAT watershed models.

## RHEM Web Tool



## Application & Resources

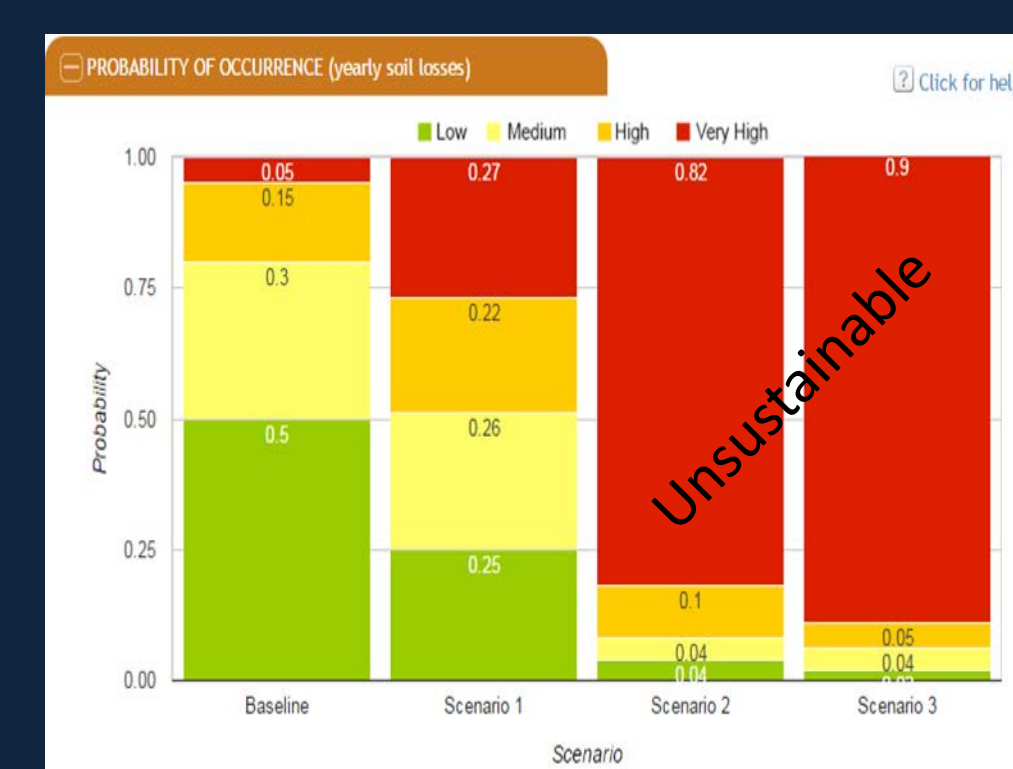
Estimating soil erosion with RHEM on Southern Arizona Limy Slopes 12-16" PZ Ecological Site; Site Type: Rangeland; Site Id: R041XC308AZ.

Input Parameters	Baseline Scenario HPC	Scenario 1 Eroded	Scenario 2 Shrub Invaded	Scenario 3 Exotic Grass
	AZ	AZ	AZ	AZ
State ID	AZ	AZ	AZ	AZ
Climate Station	Tombstone	Tombstone	Tombstone	Tombstone
Soil Texture	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
Soil Water Saturation (%)	25	25	25	25
Slope Length (m)	50	50	50	50
Slope Shape	S-Shaped	S-Shaped	S-Shaped	S-Shaped
Slope Steepness (%)	12.5	12.5	12.5	12.5
Bunch Grass Foliar Cover (%)	50	0	1	26
Forbs and/or Annual Grasses Foliar Cover (%)	1	0	2	2
Shrub Foliar Cover (%)	10	35	35	10
Sod Grass Foliar Cover (%)	0	0	0	0
<b>Total Foliar Cover (%)</b>	<b>61</b>	<b>35</b>	<b>38</b>	<b>38</b>
Basal Cover (%)	8	0	3	3
Rock Cover (%)	16	16	16	16
Litter Cover (%)	45	9	10	35
Cryptogam Cover (%)	1	0	0	0
<b>Total Ground Cover (%)</b>	<b>70</b>	<b>25</b>	<b>29</b>	<b>54</b>

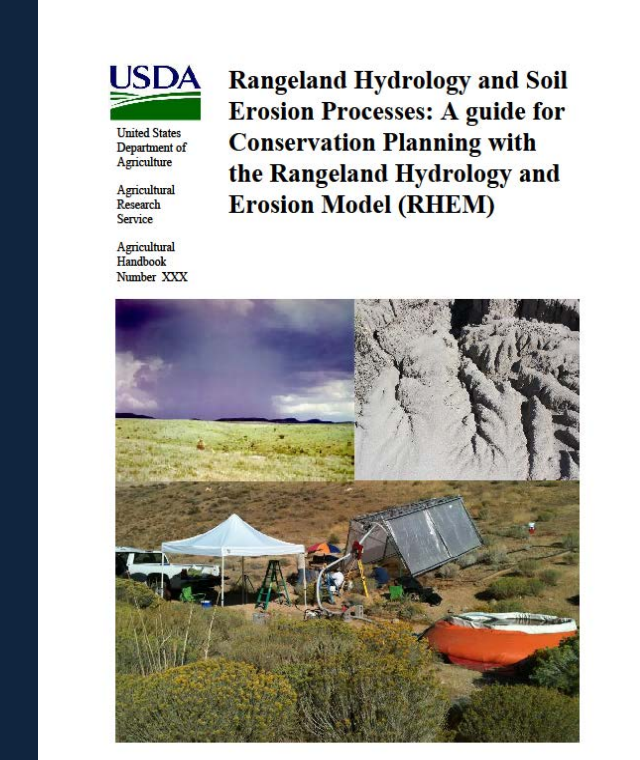
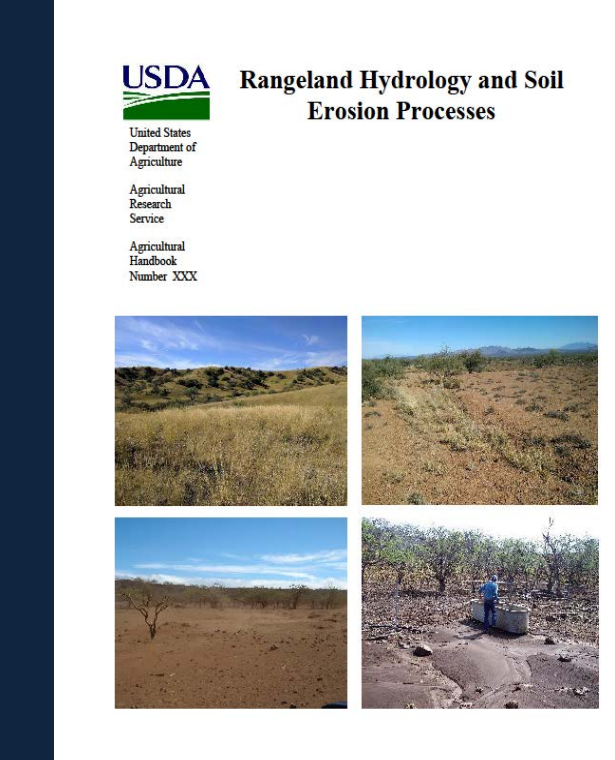
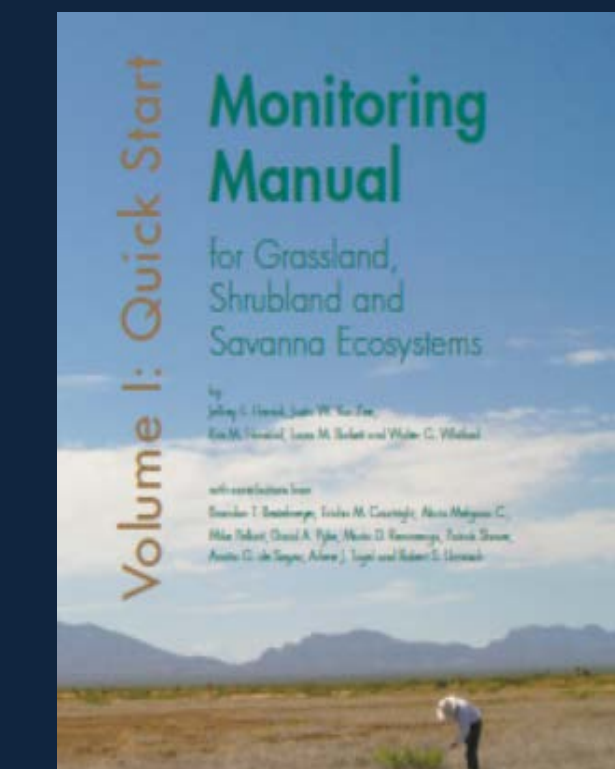
Historic (HPC) Exotic



Invaded Eroded



SOIL LOSS SEVERITY CLASS	PROBABILITY OF OCCURRENCE TABLE (yearly soil loss)			
	BASLINE SCENARIO WALNUT GREY	SCENARIO 1 WALNUT GREY EXOTIC GRASS	SCENARIO 2 WALNUT GREY SHRUB INVADDED	SCENARIO 3 WALNUT GREY EXOTIC GRASS
Low $x < 0.367$	0.5	0.25	0.04	0.02
Medium $0.367 \leq x < 0.655$	0.3	0.26	0.04	0.04
High $0.655 \leq x < 1.508$	0.15	0.22	0.1	0.05
Very High $x \geq 1.508$	0.05	0.27	0.82	0.9



## Conclusion

- ❖ Agreements are being developed to produce handbooks in Russian and English on rangeland hydrologic processes, rangeland management training courses, tools to estimate rangeland soil erosion, and techniques to estimate rangeland sustainability.
- ❖ Research is being incorporated to address salinity mobilization and estimates of Total Dissolved Solids in runoff water.
- ❖ Use ARES database and RHEM for risk assessment of sustainability based on plant community and predict soil loss probabilities.
- ❖ Applications for RHEM include: National Resource Inventory (NRI), Watershed Assessment (AGWA-KINEROS, APEX), informing Ecological Site Descriptions (ESDs,) and Ranch planning for economic and environmental sustainability.

## Author Affiliation