Sediment and Erosion Assessment Report

East San Joaquin Water Quality Coalition, Order R5-2012-0116-R1

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List of Acronyms

ESJWQC	East San Joaquin Water Quality Coalition
General Order	Waste Discharge Requirement General Order (R5-2012-0116-R1
GIS	Geographic Information System
HUC	Hydrologic Unit Code
NRCS	Natural Resources Conservation Services
MUSLE	Modified Universal Soil Loss Equation
RUSLE	Revised Universal Soil Loss Equation
SECP	Sediment and Erosion Control Plan
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SWAT	Soil and Water Assessment Tool
SWRB	State Water Resources Control Board
USDA-ARS	US Department of Agriculture-Agriculture Research Service
USLE	Universal Soil Loss Equation
WARMF	Watershed Analysis and Risk Management Framework
WEPP	Watershed Erosion Prediction Project model

Introduction

As required by R5-2012-0116-R1, the Waste Discharge Requirement General Order (General Order) for Growers in the Eastern San Joaquin Watershed, the East San Joaquin Water Quality Coalition (ESJWQC) as the third party representing growers within the Eastern San Joaquin River Watershed, is required to provide an assessment report that identifies the areas susceptible to erosion and the discharge of sediment that could impact receiving water. This Sediment and Erosion Assessment Report indicates the areas within the ESJWQC region where growers will be required to complete Sediment and Erosion Control Plans (SECPs). In addition, there are questions on the Farm Evaluation Plan that address erosion potential that will allow growers to self-identify as potential dischargers of sediment to surface waters. The combination of these two tools, the ESJWQC Sediment and Erosion Assessment Report and the Farm Evaluation self-identification, will allow the ESJWQC to identify and address erosion potential.

Background

Agricultural fields may be susceptible to erosion from both irrigation practices and storm water runoff but the potential for erosion and movement of soil to surface waters depends on a series of other factors including:

- Soil erodibility
- Rainfall
- Slope
- Vegetative cover
- Presence/absence of management practices to prevent the generation of sediment, or capture the sediment prior to entering surface waters (e.g. pressurized irrigation, use of PAM, sediment detention basins)

The ESJWQC evaluated the potential for sediment erosion based on the risk of soil mobilization due to either storm or irrigation water runoff. Erosion can result from two processes, soil mobilized by storm water runoff and soil mobilized by irrigation practices. Essentially, any flowing water can mobilize surface soils and, depending on the slope of the ground, the soil can be transported to surface waters. Flood, sprinkler, and furrow irrigation are irrigation practices that have the highest potential to mobilize sediment whereas pressurized irrigation (drip and microsprinklers) have the least potential to mobilize sediment.

Storm water falling on fields can also mobilize soil in agricultural fields and result in the movement of soil to surface waters. The greater the slope and soil erodability, the more likely a field will have sediment runoff during rain events. All these factors must be considered together since a field with furrow irrigation or with a high slope does not necessarily mean that there is an erosion issue. There are

management practices available to prevent sediment runoff (such as vegetative cover) and/or capture runoff before it enters a downstream waterbody (sediment detention basin).
Given very steep slopes and sufficient rainfall, even bedrock will eventually erode resulting in sediment deposition in surface streams. In fact, some erosion is normal and even in relatively pristine watersheds, surface waters normally carry some sediment as they move downstream. If a sediment source is eliminated, the natural energy of the stream will begin to excise the channel as the stream robs its banks of sediment. Despite the tendency to carry some sediment load, streams are often subject to anthropogenically generated sediment loads which result in impairment of their assigned beneficial uses. Therefore, the Coalition reviewed available methodologies for evaluating the risk or likelihood of sediment erosion from agricultural parcels in either storm or irrigation events considering the above listed factors.

Current Methodology for Determining Erosion Potential

The process for determining erosion potential must involve identifying the factors that control the risk of erosion, use parameters for which data are available for the ESJWQC region, can be adjusted easily as more/better information becomes available, and is a method that has been vetted in the published literature. A number of models have been developed to predict soil erosion at various scales from individual fields to entire drainage basins. These models can be separated into two groups; empirically based models and physically based models. Both types of models can be useful under the appropriate conditions.

Empirically based models tend to require less data and are easier to apply, particularly over large areas. However, empirically based models suffer from a lack of specificity and do not incorporate mechanism. Despite this, the results of empirical models can be reasonably accurate and reflect the underlying processes generating the erosion and sediment load without modeling for the actual processes t.

Physically based models attempt to capture the physics of the system and if specified properly can be used to provide significant insight into the behavior of the system of interest. They can also be more amenable to manipulation for conducting "what if" scenarios to investigate the effects of management practices on the variable of interest. However, these models may be so complex that it is difficult to determine how to translate management practices into specific changes in the model parameter values or physical processes simulated by the mathematics in the model. Generally, the downside of physically based models is that they require that the physics of the system be specified properly and there generally needs to be a large amount data available to both parameterize and validate the model.

The ESJWQC evaluated empirical and physical models that have been vetted in published literature to determine how easily the model can be adjusted with additional data and if they use parameters for which data are available within the ESJWQC region (Table 1). A brief review of representative empirical and physical based models is provided below. The review below was used to select an approach to analyzing erosion potential.

Table 1. Evaluation of empirical and physical models to be used for the ESJWQC evaluation of risk of sediment erosion.

Model Criteria	Universal Soil Loss Equations (USLE, MUSLE & RUSLE2)	Watershed Analysis Risk Management Framework (WARMF)	Watershed Erosion Prediction Project (WEPP)	Soil and Water Assessment Tool (SWAT)
1. Includes factors that control the risk of erosion	✓	✓	✓	✓
Vegetative Cover	✓ (MUSLE)	✓	✓	✓
Slope	✓		✓	✓
Soil Erodability	✓		✓	✓
Management Practices	✓	Yes	✓	✓
2. Uses parameters for which data are available for the ESJWQC region	Yes	Yes	No	No
3. Model can be adjusted easily as additional information becomes available	Yes	No	No	No
4. Method has been vetted in literature	Widely used	Has been calibrated to portions of the Central Valley	Yes	Yes
Overall Pros				
Overall Cons	Requires relatively small amount of data	Requires a large amount of data; more complex than necessary	Models the processes; requires a large amount of data	Models the processes; requires a large amount of data

Universal Soil Loss Equation

The Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) is one of the most widely used empirical models for estimating soil loss from agricultural basins. It was developed from field studies in the Midwest and was originally parameterized for small watersheds in central Iowa. Since its development, it has been applied to agricultural watersheds throughout the world.

The model is a single equation using six variables to estimate the annual soil loss under specific rainfall conditions:

$$A = R \times K \times L \times S \times C \times P$$

where A = annual soil loss, R = rainfall erosivity (rainfall intensity), K = soil erodability (in mg MJ^{-1} mm^{-1}) when the field is bare, L = slope length, S = field slope, C = crop management factor, and P = conservation practice. The parameter C can be further decomposed into:

$$C = (\sum_{1}^{j} (f_j \times c_j))/m$$

Where *j* is the index for crop stage periods, N = the number of crop stages over the analysis period, and m is the number of years in the analysis period. The cover management factor c is assumed to be constant across any single crop stage but can vary across crop stages. Also, the equation treats all rainfall as if there is a single rain event. No accounting for storm to storm variation is possible with the original USLE.

The equation was originally developed for application on a relatively small scale, e.g. individual fields or small regions, but with the advent of sophisticated Geographic Information System (GIS) software, has been applied across large landscapes. The problem with application across a wide area is the need to properly define and provide numeric values for the C and P terms in the equation. As originally developed, the C and P terms required substantial information about crop management and conservation practices applied to specific fields. As the application of the USLE was scaled up, the information on C and P became more difficult to acquire for all fields and more difficult to identify the value the variables were to assume. However, C and P were categorized and numeric values developed for standard management and conservation practices providing some consistency across applications. However, unless information is known about C and P at a fine scale, the problem of properly parameterizing the model at the scale of the landscape remains.

Modified Universal Soil Loss Equation

The Modified Universal Soil Loss Equation (MUSLE) was developed to add additional specificity to the rainfall event driving the erosion and has been used throughout the world (e.g. Sadeghi and Mizuyama

2010). The equation was increased to seven variables by expanding rainfall erosivity to include terms for both the amount of rain and the peak flow rate which provides an estimate of rainfall intensity. The MUSLE equation is:

$$S = 11.8(Q \times q_p)^{0.56} \times K \times L \times S \times C \times P$$

where S = sediment yield in tons, Q = runoff volume in m^3, q_p is peak flow rate in m^3s^{-1} and K, L, S, C, and P are the same factors as from the USLE.

Revised Universal Soil Loss Equation

The Revised Universal Soil Loss Equation (RUSLE) is the most recent advance in the USLE family of equations and has been used extensively (e.g. Evans and Seamon 1997) and was developed in an attempt to bring greater flexibility to the model by incorporating quantification of both rill and interrill erosion. There are two versions of the model, RUSLE1 and RUSLE2. The equations are the same as for the USLE except estimates are made on a daily basis and summed to estimate annual sediment yield. According to the RUSLE2 manual, the RUSLE2 can be used to estimate soil loss across large areas by selecting sample points over an inventory area and calculating the soil loss for each sample point. The loss is then aggregated to estimate soil loss across the entire area. The user's manual warns that the user should not use spatially averaged values for slope length and steepness, soil characteristics, and cover-management conditions or attempt to calculate soil loss using these spatially averaged values. Using spatial averaging introduces inaccuracies due to the nonlinearities in the RUSLE2 equations.

The RUSLE1 and RUSLE2 equations are similar to those of the USLE with the decomposition of the K term in RUSLE1 becoming:

$$K = \left(\sum_{1}^{k}(f_k \times k_k)\right)/m$$

Where K is erodability, f and m are as above and k is the number of crop stages. RUSLE2 incorporates sediment detachment/deposition dynamics which includes fall velocity of sediment in still water, overland flow rate per unit width of flow, transport capacity and sediment load. RUSLE2 computes the runoff rate using a 10 year storm erosivity term, the NRCS curve number method and a runoff index computed using cover-management variables (USDA-ARS 2003). The improvement of RUSLE2 over RUSLE1 and the USLE is in the handling of several classes of soil particles and the method used to solve the equations providing a more accurate estimate of soil loss.

Watershed Analysis Risk Management Framework and Similar Models

The Watershed Analysis and Risk Management Framework (WARMF) uses equations originally developed in the ANSWERS model. The model simulates almost every physical process that can affect watersheds including rainfall, snowfall, runoff, nutrient dynamics, dry atmospheric deposition, and many more. The model simulates detachment and transport of clay, silt, and sand separately. Detachment is due to kinetic energy of rainfall and turbulence of overland flow. Rainfall detachment utilizes soil erosivity, rainfall intensity, a rainfall detachment factor, and a cropping factor. Turbulent flow detachment utilizes slope, erosivity, flow per unit area, detachment factor, and cropping factor. Both rainfall detachment and turbulent flow detachment scale to the area of the catchment to estimate total erosion from the watershed on a daily, monthly, or yearly basis. The model also incorporates several equations for deposition of sand that depends on shear stress, shear velocity, Reynolds number, and critical shear stress. Clay and silt are assumed to remain in suspension until they are delivered to a stream. The model takes a significantly large amount of data to calibrate and validate although default values are available for many parameters.

Additional physically based models include the Watershed Erosion Prediction Project model (WEPP, http://www.ars.usda.gov/Research/docs.htm?docid=10621) and the Soil and Water Assessment Tool (SWAT, http://swat.tamu.edu/software/swat-model/). WEPP uses physically based equations to estimate the sediment generation and transport processes (infiltration, surface runoff, plant growth, residue decomposition, hydraulics, tillage, management, and erosion mechanics) at the hill slope and in-stream scales of measurement. SWAT, developed jointly by US Department of Agriculture-Agriculture Research Service (USDA-ARS) and Texas A&M AgriLife Research and Extension, is a river basin or watershed model developed to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large complex watersheds. SWAT requires specific information about weather, soils, topography, vegetation, and land management practices occurring in a watershed. SWAT directly models water movement, sediment movement, nutrient cycling, chemical transformation and transport, bacterial transport, and the effect of several land management practices on these processes. Many of the equations used in WARMF are the same equations used in SWAT and many other physically based models as the physical processes describing various processes, such as evapotranspiration, were developed long ago and are simply inserted into the models. As with WARMF, the data demands of SWAT are considerable and the list of variables used in the model stretches for several pages in the theoretical documentation manual (Neitsch et al. 2009).

ESJWQC Methodology

The objective of the current assessment is to estimate erosion potential across the ESJWQC region. Once areas that have the potential to generate sediment have been identified, growers in those areas will be requested to complete a Sediment and Erosion Control Plan (SECP). It is not necessary to estimate actual soil loss under any particular set of climatic/weather conditions, or any specific set of management conditions. Whether a grower has previously implemented management practices to prevent erosion does not change the potential for the ground to erode. And, if the property is sold to another grower who changes commodities and management practices, the fields may experience significant erosion. The critical factors for determining whether or not a grower needs to complete a SECP are the natural conditions/features that contribute to erosion and the potential for the sediment to move to surface waters. Consequently, the process for determining erosion potential needs to identify the factors that control the risk of erosion, use parameters for which data are available for the ESJWQC region, can be adjusted easily as more/better information becomes available, and is a method that has been vetted in the published literature. Based on the assessment criteria and overall pros and cons summarized in Table 1, the ESJWQC utilized variations of the Universal Loss Equation (MUSLE and RUSLE).

The factors that influence erosion are rainfall amount and intensity, soil characteristics such texture, structure and cohesion, vegetation cover, and slope. As indicated above, vegetation cover can change and while it mitigates erosion potential, an evaluation of erosion potential should not consider vegetation. The vegetation cover should be considered as a constant across the ESJWQC region. Similarly, rainfall is important for determining erosion potential, and there is a gradient in precipitation with greater precipitation occurring in the north of the Coalition region and less precipitation occurring in the south. While the gradient does occur, the ESJWQC region is sufficiently small that the variation in annual rainfall amounts that occurs across the region from year to year is comparable to the variation that occurs within the region in any particular year. Consequently, evaluation of erosion potential can be determined using a standard rainfall conditions applied to the entire ESJWQC region. Slope length is a function of the size of the field over which water is run, either from stormwater or irrigation supply water. Fields size can be relatively labile with respect to the geographic setting of the Coalition. For example, there is no reason to assume that any particular field size or shape is more common in one portion of the Coalition region than in another part of the Coalition region. As a result, an average field length can be assigned to all fields in the Coalition region.

Within the framework of a model, standard conditions really act as mathematical linear operators on the key features of the models. If all models are run using a standard 2 inch rainfall event with a specific cropping regime and a specified conservation practice, these factors become unimportant for determining erosion potential.

The ESJWQC is using an empirical modeling approach, specifically the USLE family of equations, to evaluate erosion potential. These equations capture the two variables most critical to the analysis; soil erodability and slope. For example, when using the MUSLE:

$$A = 11.8\left(Q \times q_p\right)^{0.56} \times K \times L \times S \times C \times P$$

where A is the annual soil loss, the values of Q, q_p, C, L, and P can all be treated as constants and removed from the model.

The erosion potential becomes an equation based on K (erodability) and S (slope). These data are obtainable from GIS coverages available for the Coalition region.

In addition to calculating an erosion potential based on parameters in established models, there are additional measures that could be used as measures of erosion potential. Hydrologic soils group and runoff potential are two designations from the Natural Resources Conservation Services (NRCS) that provide some insight into the potential for the land surface to contribute sediment to surface waters.

Hydrologic Soils

Hydrologic soil groups are classified based on estimates of runoff potential. Soils are assigned to a hydrologic soil group based on 1) the rate of water infiltration when no vegetation is present, 2) are saturated, and 3) precipitation received from long-duration storms. Soils are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). As soils grade from Group A to Group D, the infiltration rate (when saturated) changes from high (low runoff potential) to low (high runoff potential). Group A soils consist mainly of deep, well drained to excessively drained sands or gravelly sands. Group D soils consist of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over nearly impervious material.

Soils can be assigned to a dual hydrologic group (A/D, B/D, or C/D) based on a combination of the drainage areas and the second is for undrained areas within the area. Only the soils in their natural condition are in group D and are assigned to dual classes.

Runoff Class

Surface runoff refers to the loss of water from an area by flow over the land surface. Runoff class is the runoff potential class for the soil. The surface runoff class is assigned with the assumption of no vegetation cover and low surface water retention due to irregularities in the ground surface. Finally, the maximum bulk density in the upper 25 cm and the bulk density of the uppermost few centimeters are assumed within the limits specified for the mapping concept. The concept assumes a standard storm. Additionally, a standardized antecedent water condition is assumed with the soil being very moist or wet.

Both runoff class and hydrologic soils groups are compared to the erosion potential map that is generated by the combination of parameters from the USLE family of equations.

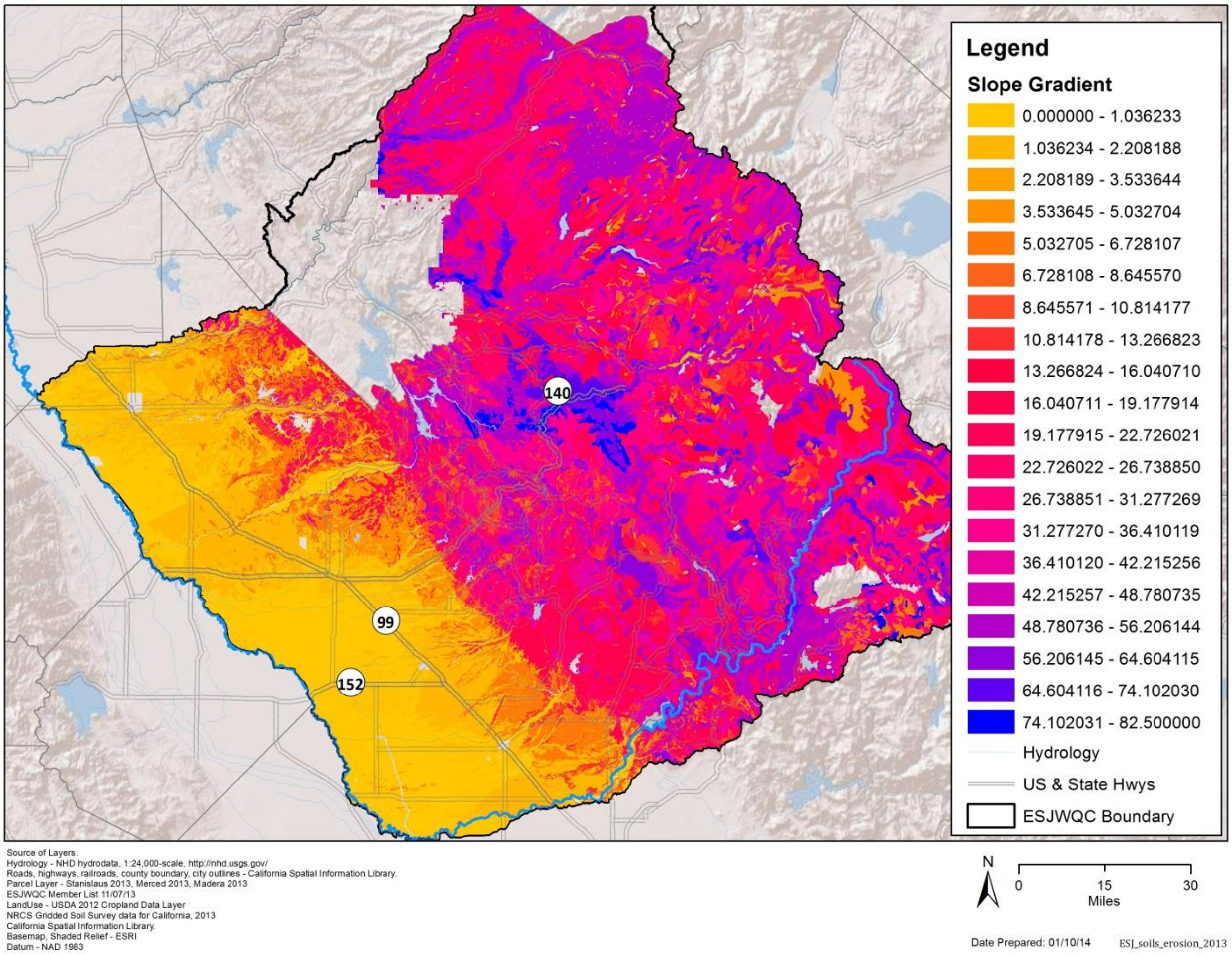
Soils data from NRCS (Gridded Soil Survey data for California, 2013) were utilized and the components K and S were evaluated using cropping data from USDA Cropland Data (2012).

Soils

Soils data for the ESJWQC boundary are relatively complete but a gap exists in the data for the western portions of Tuolumne & Calaveras Counties. Fortunately, very little agriculture occurs in these areas.

Slope data were obtained using the representative slope gradient (slope_r, Component table, NRCS soil Survey data) which reports the difference in elevation between two points and is expressed as a percentage of the distance between those points.

Figure 1. Map of slope in the ESJWQC region.



Slope ranges from almost level to almost 82% (Figure 1). Although, the majority of the steeper slopes are located within the Sierra Nevada and are not associated with the ESJWQC region. However, recent development of the Sierra Nevada foothills for commodities like almonds has resulted in many areas with relatively steep slopes becoming categorized as agricultural land. The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) recently mapped erosion potential of the state and classified land over 4% slope as being susceptible to erosion and therefore, any areas with $S \geq 4$ were considered to be at elevated risk of erosion.

Soil erodibility factor was obtained from GIS coverages of K_w which quantifies the susceptibility of soil particles to detachment and movement by water and is adjusted for the effect of rock fragments. Erodibility ranges from 0.02 to 0.65 (Table 2). All moderate textured loams and high silt content soils were considered to be potentially susceptible to erosion and therefore, any areas with $K \geq 0.20$ were considered to be at elevated risk for erosion. The GIS coverage of K factor was obtained from the Soil data from NRCS (Gridded Soil Survey data for California, 2013) (Figure 2).

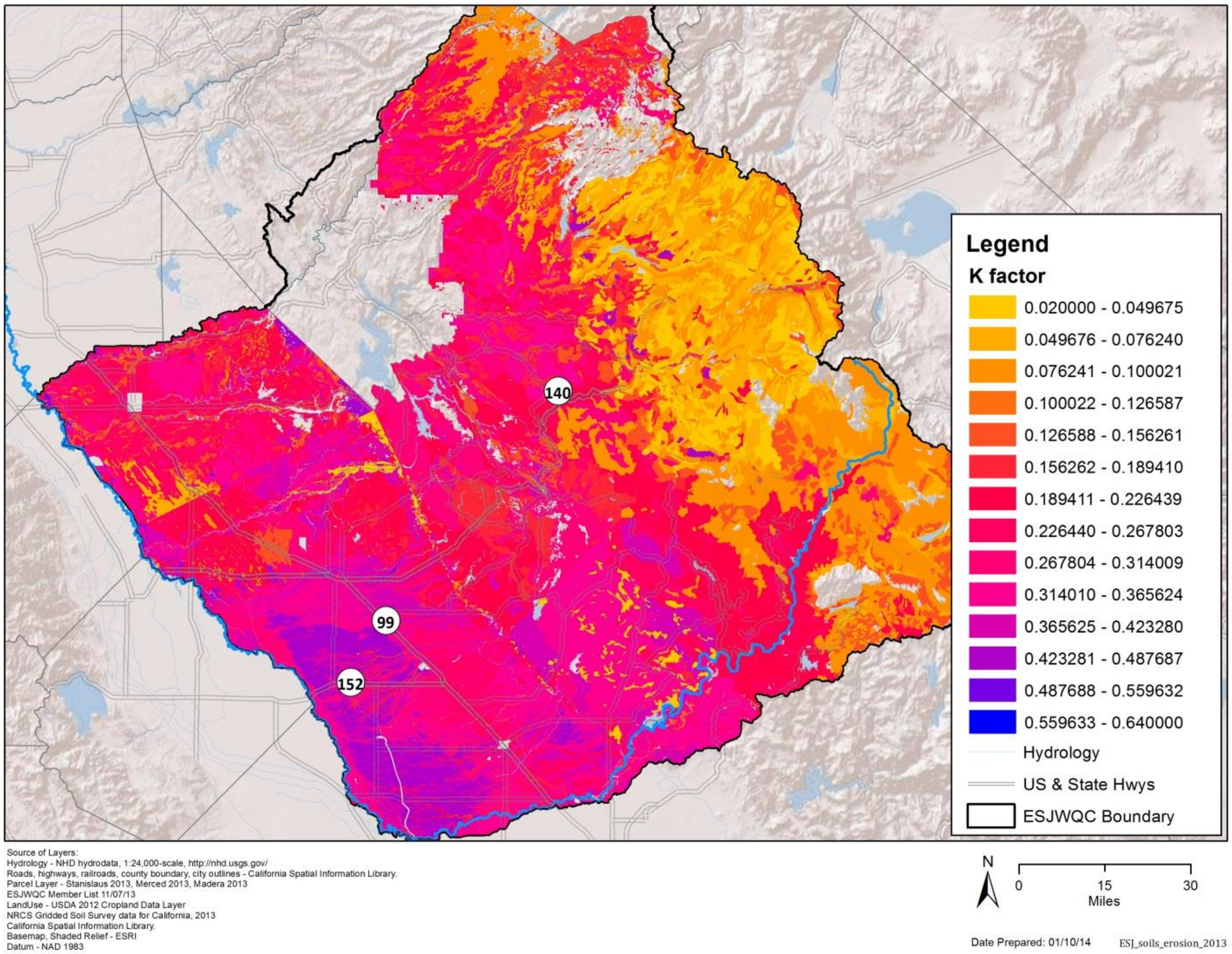
Table 2. Soil characteristics associated with K (soil erodability) values.

Fine textured, high clay	low	0.05 – 0.15
Coarse textured, sandy	low	0.05 – 0.20
Medium textured, loams	moderate	0.20 – 0.45
High silt content	high	0.45 – 0.65

In addition to these MUSLE components, hydrologic group (hydrgrp, Horizon table) and runoff class (runoff, Component table) were also evaluated. Data were filtered using a 30 cm top-depth for soils. This depth represents the soils that are involved in tilling and potentially in erosion. Data analysis comparing K*S to runoff and K*S to hydrologic groups were performed to determine best factors for erosion potential of soils.

For the Coalition region for which data were available, the product of K (Figures 2 and 3) and S (Figure 4) was calculated for the entirety of the Coalition region (Figures 5 and 6). Two maps were generated from these data. The first is the map of all the K*S values divided into 20 categories (Figure 5) developed by ArcGIS using a geometric classification. The second map is of two categories; those K*S values ≥ 0.8 and those < 0.8. The values of ≥ 0.8 represent all areas with the minimal erodibility and minimum slope that is considered as an erosion potential. This value also captures the combination of all K factor and slope values that in combination may identify the area as high risk although either of the factors may by itself not qualify as having a high risk for potential erosion. For example, highly erodible soils on relatively flat land may be at risk from furrow or flood irrigation even though the natural slope is not sufficient to trigger erosion. Alternatively, clay or sandy soils on steep slopes may be susceptible to erosion even though the soils are not considered to have high erosion potential.

Figure 2. K factor in the ESJWQC region including all four K factor categories.



Results and Discussion

Erosion Potential

An index of erosion potential was calculated as the product of K and S:

$$EP = K \times S.$$

For the Coalition region, the product of S (Figure 1) and K (Figure 2) was calculated for the entirety of the Coalition region. Two maps were generated from these data. The first is the map of all the K*S values divided into 20 categories (Figure 3). The second map is of two categories (Figure 4); K*S values ≥ 0.8 are high potential areas outlined in red and K*S < 0.8 are low potential areas outlined in green.

Figure 3. The product of K and S assigned to 20 categories.

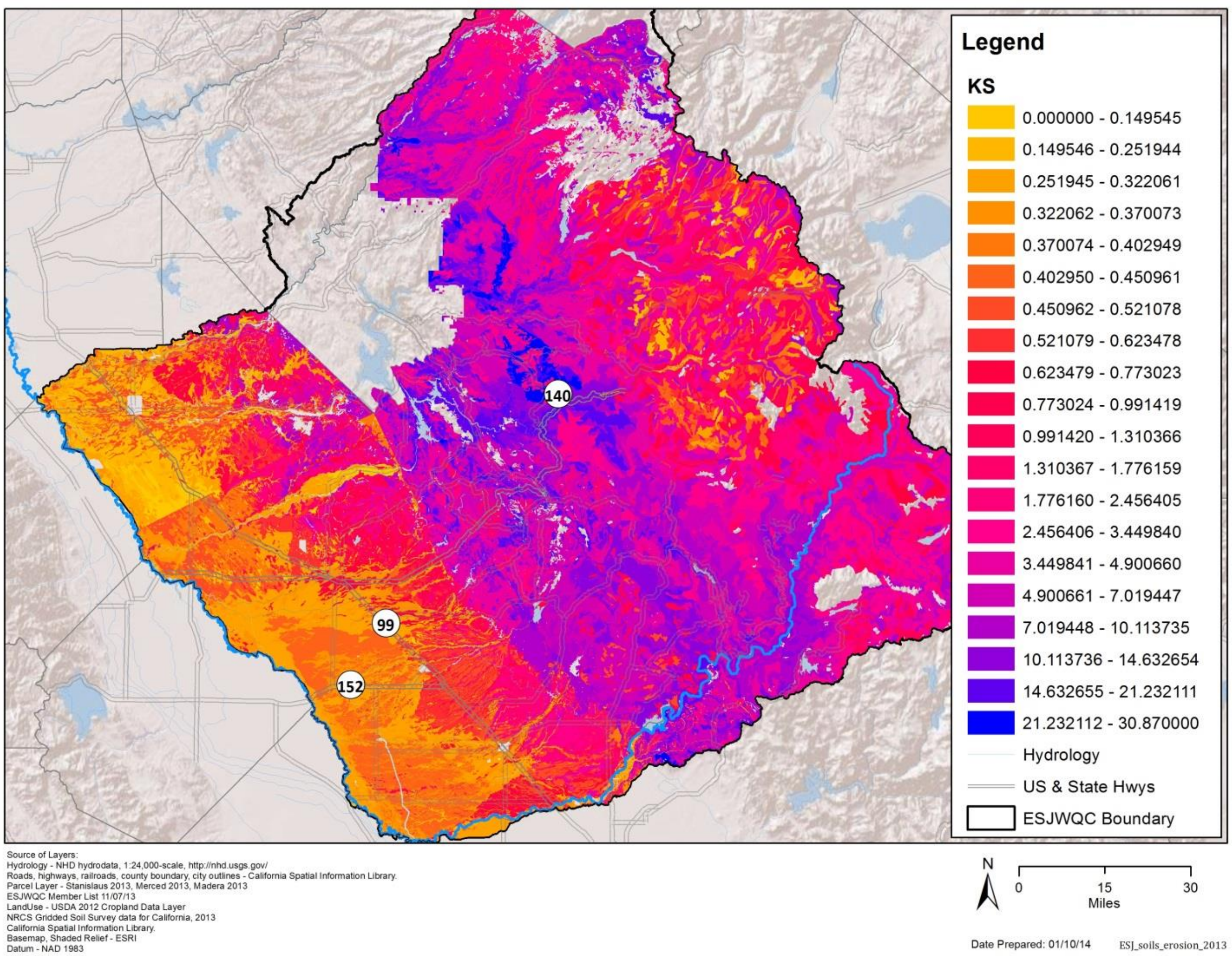
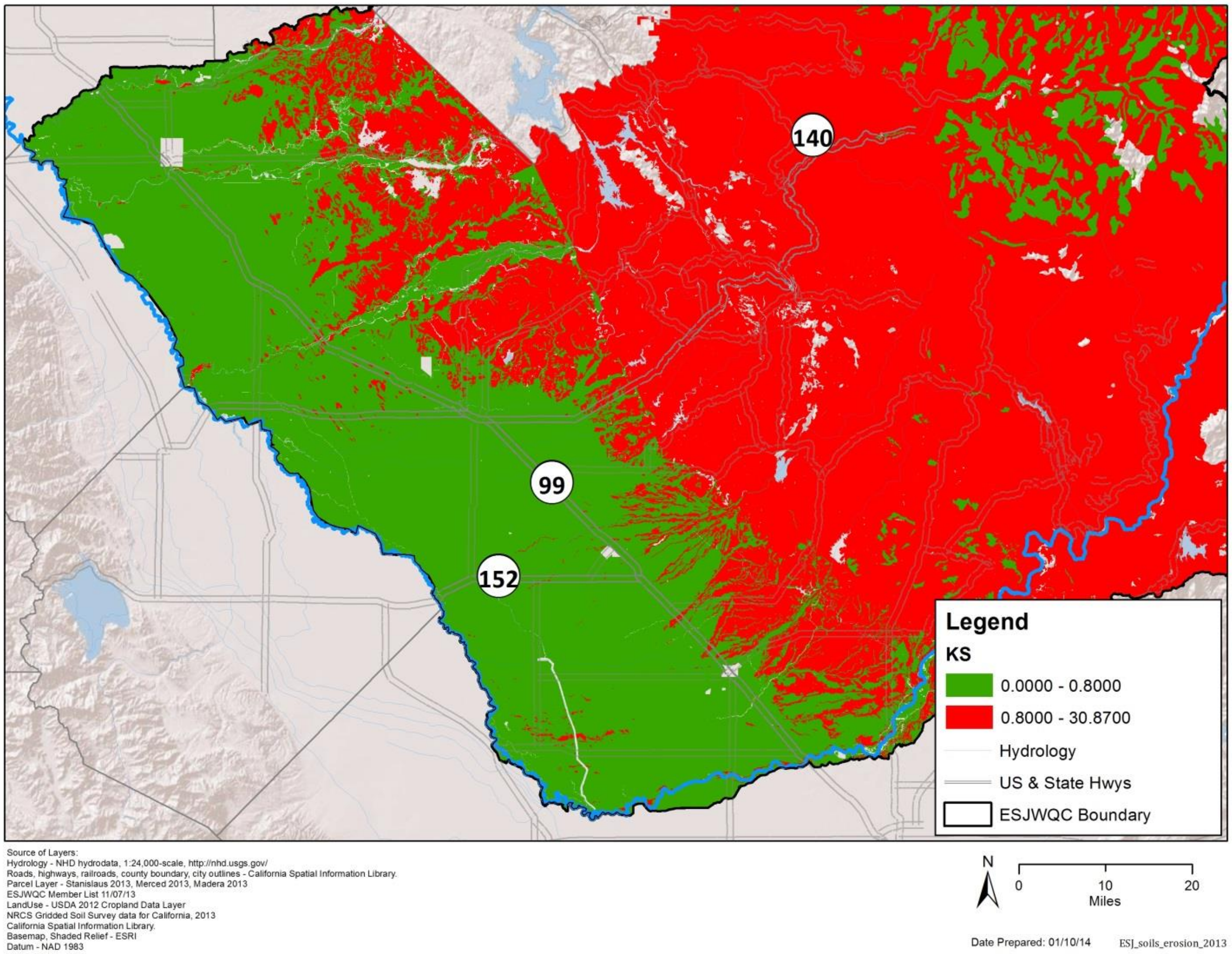


Figure 4. The product of K and S assigned to values ≥ 0.8, and values < 0.8 (green, low erosion potential) and ≥ 0.8 (red, high erosion potential).



The areas in red in Figure 4 represent all areas within the ESJWQC region that have a potential for erosion. Although some of the acreage is located on the valley floor and in the foothills where new orchards are being developed, the majority of the area is located in the Sierra Nevada above the region of irrigated agriculture. To identify which high erosion potential lands are located on agricultural lands, the map in Figure 4 was combined with the 2012 USDA crop layer (Figure 5) to provide an assessment of the irrigated land within the ESJWQC that has a high potential for erosion (Figure 6). The final overlay is the map of member parcels (Figure 7) with the map of erosion potential (Figure 4) to identify ESJWQC members located on high erosion potential land (Figure 8).

Figure 5. Agricultural land within the ESJWQC region based on 2012 USDA crop classification.

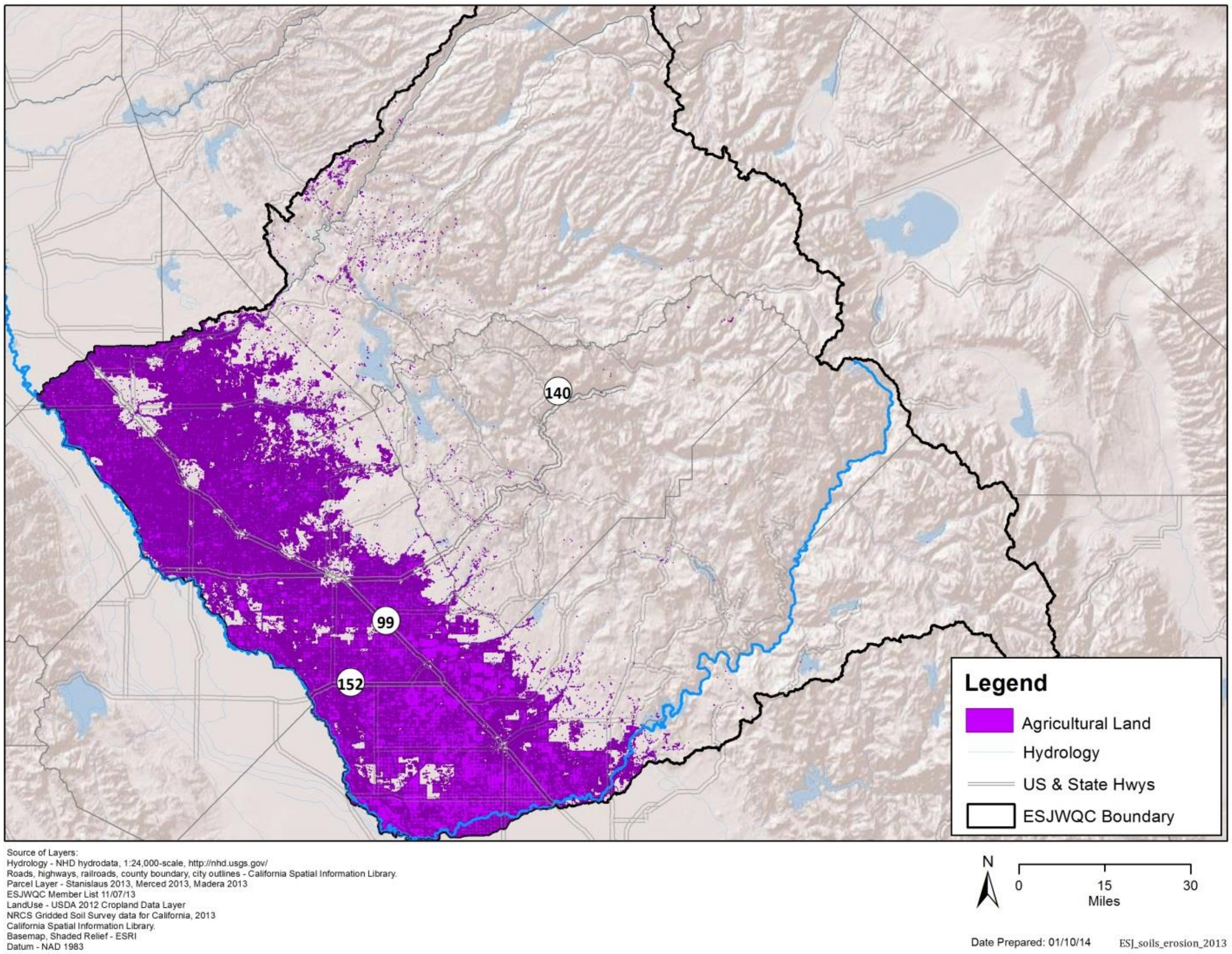


Figure 6. ESJWQC member parcels based on 2013 membership.

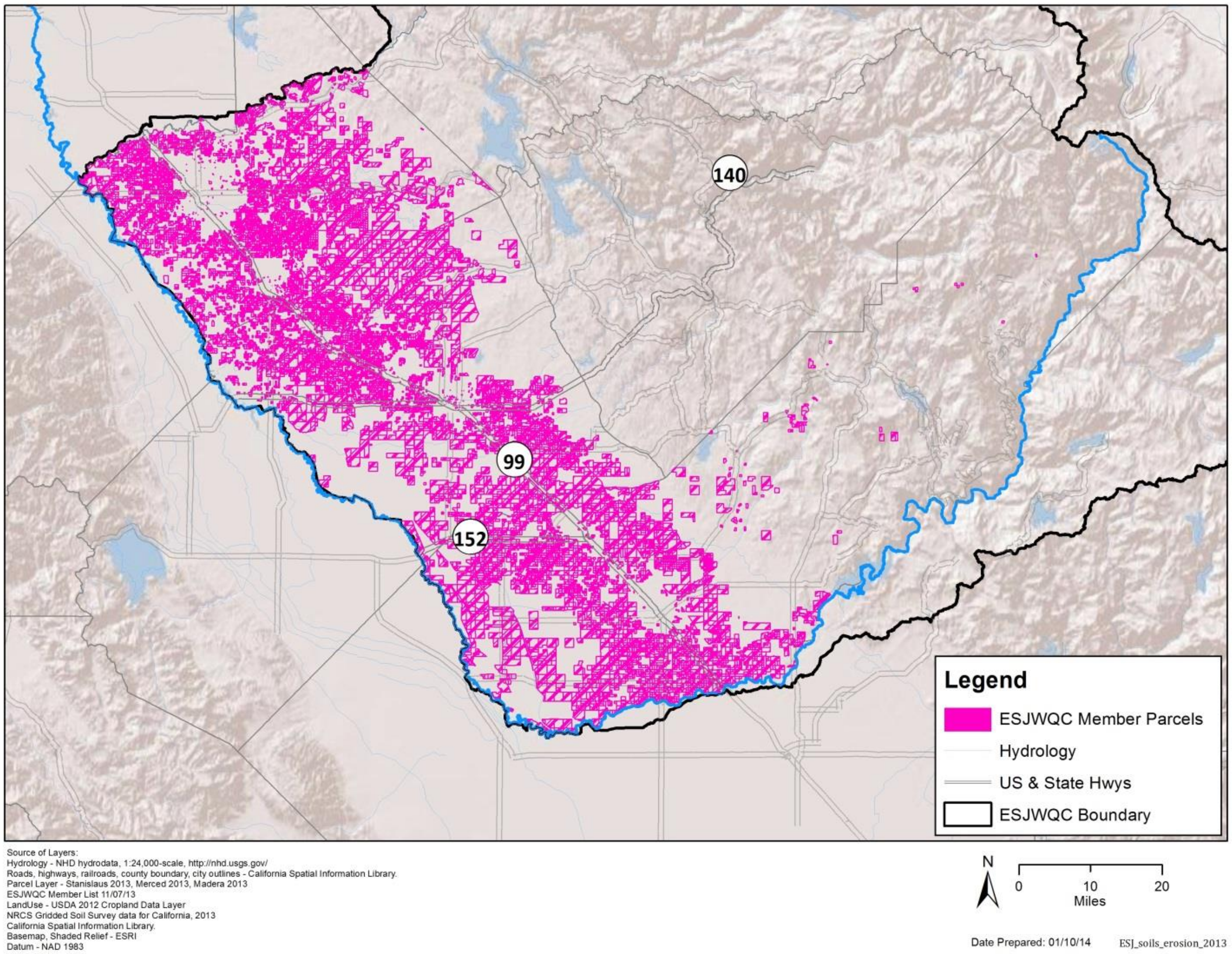


Figure 7. High (KS≥0.8) and low erosion potential (KS<0.8) land on agricultural land in the ESJWQC region.

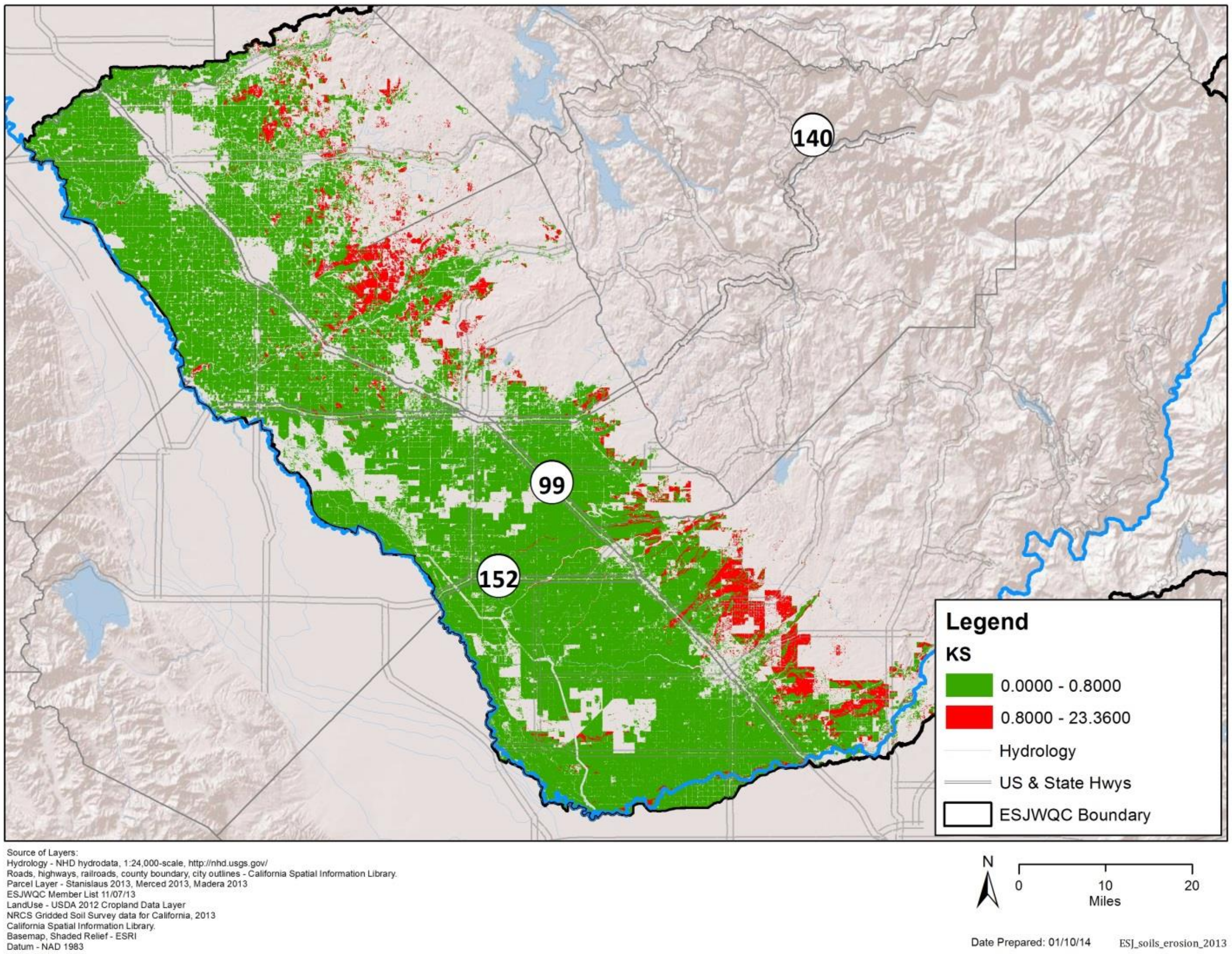
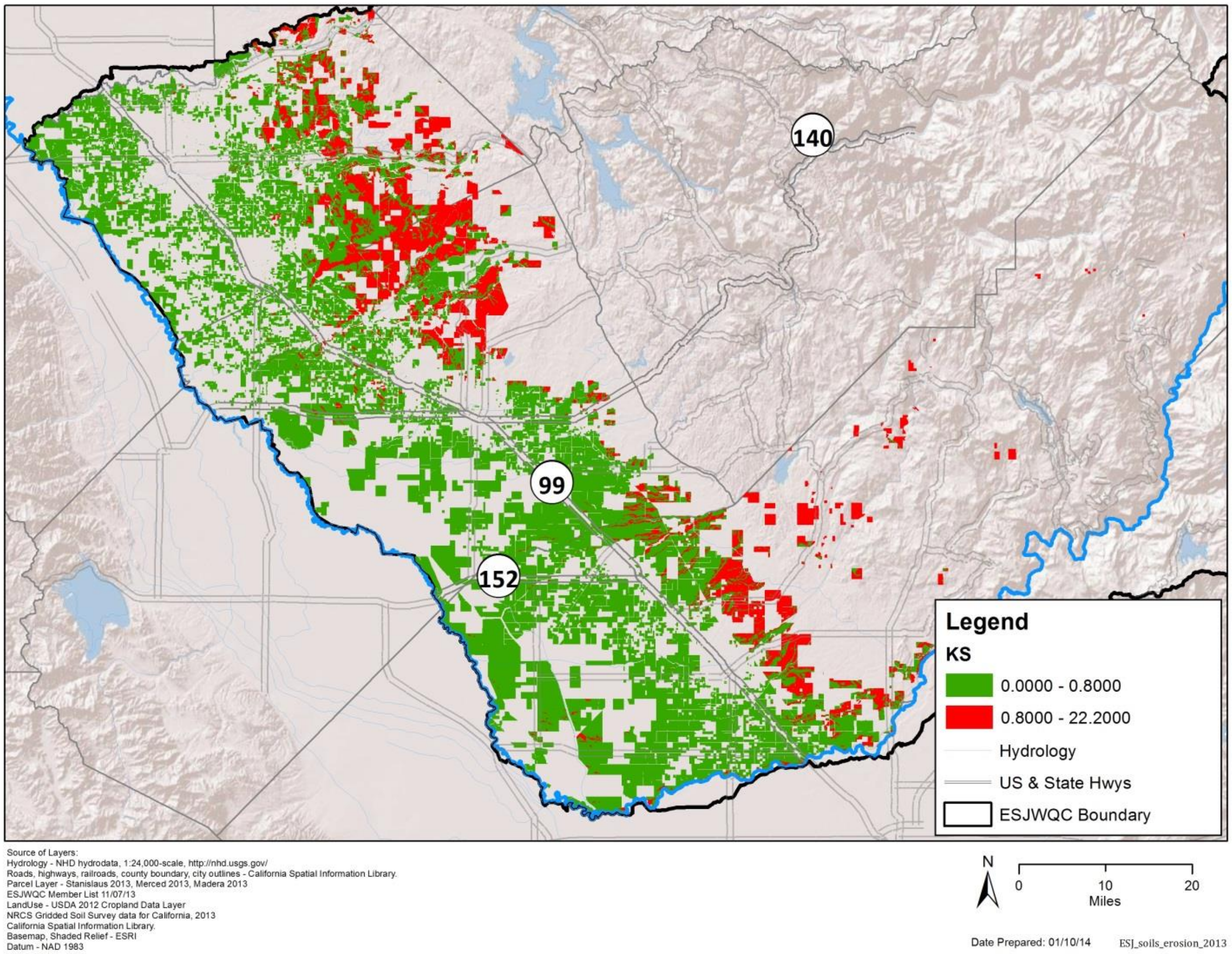


Figure 8. High (KS ≥ 0.8) and low (KS < 0.8) erosion potential ESJWQC member parcels.



Comparison to State Board High Risk Watersheds

In 2012, the State Water Resources Control Board (SWRCB) released a GIS methodology for designating high risk watersheds as guidance for the Risk Level Determination in the Construction General Permit. The guidance enables any discharger to determine the risk level for any receiving water in which a construction project is being contemplated. Their High Risk watersheds are any Hydrologic Unit Code (HUC) Level 12 watersheds that drain to waterbodies that are either 1) on the 303d list as being impaired by sediment/siltation or turbidity, 2) have an US EPA-approved TMDL for sediment, or 3) have existing beneficial uses for SPAWN, MIG, AND COLD according to the most recent Basin Plan for the region. The statewide high risk map was published (Figure 9).

The map generated by the SWRCB suggests that the Central Valley region is relatively free of sediment problems, primarily because there are few waterbodies that are 303d listed for sediment, and there are few waterbodies with SPAWN, MIG, and COLD assigned beneficial uses. Although fine details on the map are difficult to see, the three watersheds that have SPAWN, MIG, and COLD beneficial uses are the Stanislaus, Tuolumne, and the Merced Rivers downstream of the last major reservoirs (New Melones, New Don Pedro, and McSwain Reservoirs; Figure 9). There are no waterbodies in the ESJWQC region that are on the 2010 303d list for sediment/siltation or turbidity. Consequently, the high risk regions identified by the SWRCB process are not a reasonable representation of the potential for erosion. They are a measure of potential for impairment of a waterbody if erosion was to occur but in the ESJWQC region, the risk ranking does not address erosion potential.

Discussion

The measure of erosion potential in this report is based on a basin-wide calculation using the USLE family of equations. These equations have been used for decades to estimate annual erosion from irrigated agricultural land. For a majority of published studies, the purpose is to estimate annual erosion for a specific and relatively small location for which it is possible to determine values for all of the parameters in the model. For the current exercise, application of the USLE equations to the entire ESJWQC region is not possible because there are insufficient data available at a scale that would allow the equations to be parameterized on a parcel by parcel basis. Alternatively, conditions can be averaged over a larger area, reducing the number of parcels for which the equation must be solved, simplifying the calculations.

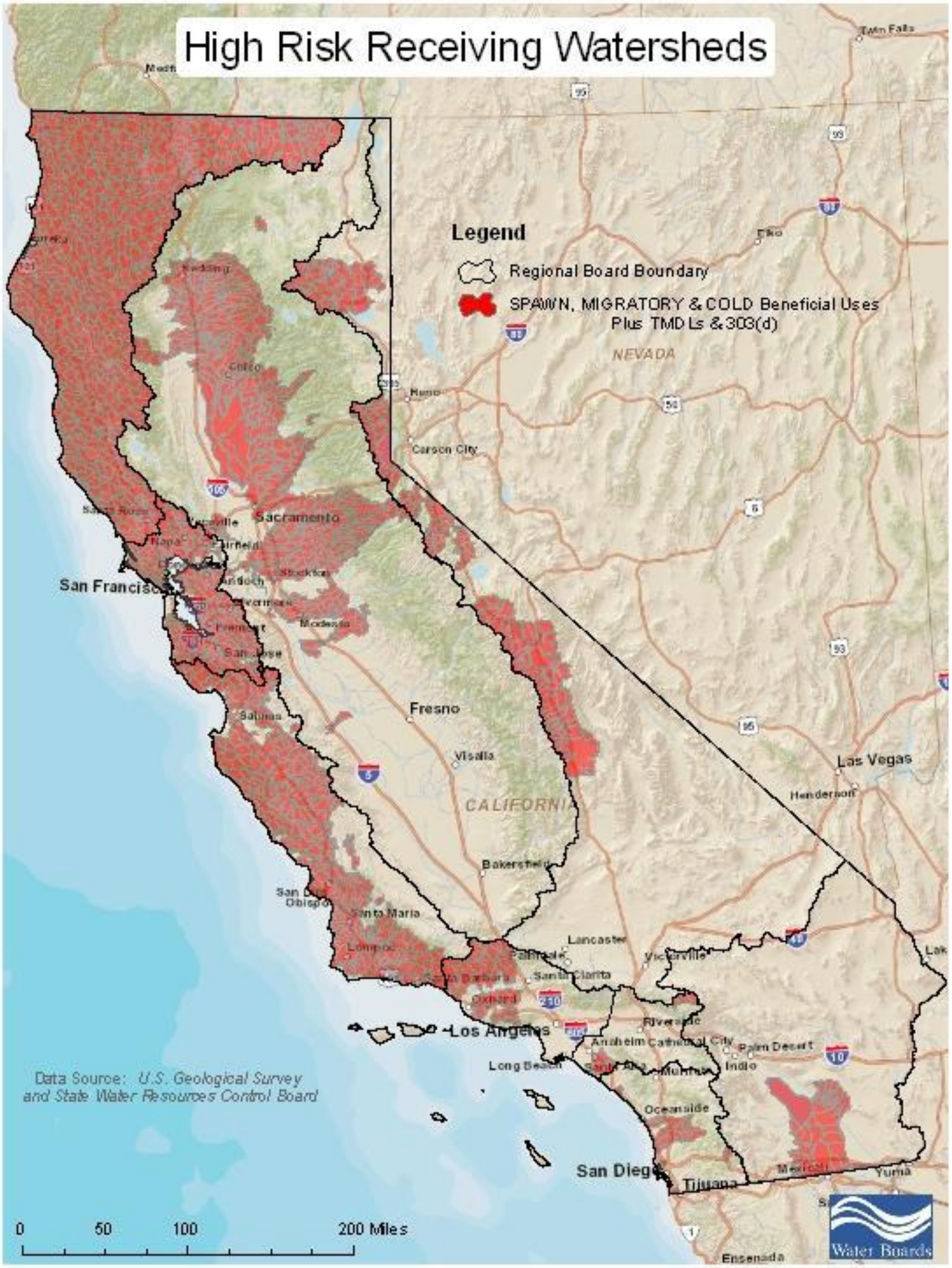
An alternative is to utilize physical based models to estimate erosion potential; however, these models require a substantially large amount of data to run. In many applications, models such WARMF utilize values of the parameters averaged over a larger area such as a square kilometer or square mile.

If the goal is to measure erosion from land, both types of models can be used effectively by providing average values for entire regions. In fact, if parameter values are averaged across entire regions, they can be treated as constants and dropped from the analyses. In empirically based models such as the USLE models, the constant terms can be eliminated from the equations completely which greatly simplifies the analysis. Physically based models can't be run without all of the equations, and consequently, still require parameter values for all variables in all equations in the models. Although default values can be used for some of the variables, these only allow a slight simplification of the analysis.

The ESJWQC simplified the USLE equations to two terms, soil erodability and slope, to estimate erosion potential across the ESJWQC region. Erosion potential was quantified as the product of the two terms. The critical value used to determine the areas within the ESJWQC region that have the potential for erosion and those that do not have a potential for erosion is 0.8. Values ≥ 0.8 are considered to have a high erosion potential, those < 0.8 have low erosion potential. This cutoff value represents a combination of the minimum values of each parameter (slope ≥ 4% and erodability ≥ 0.2) that are seen as having a potential for erosion. Using the product of the two parameters allows for the potential for erosion from areas that may have shallower slopes but highly erodible soils or relatively stable soils on very steep slopes.

Based on this analysis, the majority of the ESJWQC region has low erosion potential. Areas of high erosion potential exist in the eastern side of the Valley where agriculture extends into the foothills of the Sierra Nevada Mountains. There are some erodible soils that extend west from the foothills south of Modesto but the majority of the high erosion potential lands are located to the east of Highway 99. There are larger amounts of high erosion potential land in the northern portion of the ESJWQC region relative to the south. There are some high erosion potential parcels located to the west of Highway 99 that reflect high soil erodability rather than high slope.

Figure 9. SWRCB high risk watersheds. Taken from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/.



Next Steps

With the approval of the Sediment and Erosion Assessment Report, the ESJWQC will contact members located in the areas identified as having a high potential for erosion and request that those members complete the SECP. Those plans will be maintained at the headquarters of the farming operation.

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