An Overview of the Oregon Water Quality Decision Aid (OWQDA)

A tool for assessing groundwater contamination risk from specific soil-pesticide combinations

J.H. Huddleston

The Oregon Water Quality Decision Aid (OWQDA) is a first-tier screening tool that allows you to make a broad determination of the likelihood that a specific chemical, when applied to a specific Oregon soil, will move through the soil and contaminate groundwater. This determination is called the groundwater vulnerability rating.

Interactions between soil properties and chemical properties control the groundwater vulnerability rating. Soil property evaluation leads to a rating of soil sensitivity. Chemical property evaluation leads to a pesticide movement rating. These parameters are discussed briefly in this publication. Further information is available in other OSU Extension Service publications (see "Related OSU Extension materials," page 4).

The OWQDA is a two-way table that assigns a groundwater vulnerability rating to each specific combination of soil sensitivity and pesticide movement ratings (Table 1). There are five classes of groundwater vulnerability ranging from very low to very high. General interpretations of these ratings and some implications for use and management of chemicals on soils are discussed more fully on page 3.

How to use OWQDA

OWQDA can be used in either manual form or computer-assisted form. In either case, OWQDA uses two comprehensive databases, one for soils and the other for chemicals. Both databases are available from the OSU Extension Service either in hard copy or in a completely automated computer version of OWQDA.

For manual operation, you need to obtain:
- The soil sensitivity database for the county or counties of interest from the OSU Department of Soil Science
- The OSU Extension Pesticide Properties Database, EM 8709
- You also should obtain Site Assessment for Groundwater Vulnerability to Pesticide Contamination, EM 8560, which contains a detailed step-by-step procedure for using OWQDA and a set of worksheets for recording all pertinent data.

For computer operation, you need to obtain EM 8706, Oregon Water Quality Decision Aid (OWQDA) Computer Software. This software contains complete databases for both soils and pesticides and generates all pertinent ratings as soon as you select specific soils and pesticides of interest.

For ordering instructions for these publications and computer software, see page 4.

Soil sensitivity ratings

Soil sensitivity is a composite measure of a soil's tendency to allow a chemical to be transported all the way through the soil profile to groundwater. Soil sensitivity depends on the soil's leaching potential, its sorption potential, and the hydraulic loading on the soil.

Leaching potential is a measure of the driving force available to move chemicals down through the soil. Factors influencing leaching potential are soil permeability, soil depth to bedrock or a water table, soil slope, and the balance between infiltration and runoff.

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http://extension.oregonstate.edu/catalog
Sorption potential is a measure of the soil's ability to retain chemicals by reactions between the chemicals and particles of clay and organic matter. Factors influencing sorption potential are the amounts of organic matter and clay in the soil.

Hydraulic loading is the amount of water available at the soil surface to create leaching conditions. Factors influencing hydraulic loading are the amount of rainfall and whether or not the soil is irrigated.

Further information about these factors and the criteria used to formulate soil sensitivity ratings is available in the following OSU Extension publications (see page 4 for ordering information):

- Determination of Soil Sensitivity Ratings for the Oregon Water Quality Decision Aid, EM 8708
- How Soil Properties Affect Groundwater Vulnerability to Pesticide Contamination, EM 8559
- Introduction to the OSU Extension Soil Sensitivity Database, EM 8707

Soils having very low or low sensitivity tend to be slowly permeable and high in organic matter. In these soils, leaching is limited and there is maximum retention of chemicals by sorption into organic matter. Soils having high or very high sensitivity tend to be rapidly permeable and low in organic matter. They transport chemicals very readily and have very little capability to retain them.

Pesticide movement ratings

Pesticide movement ratings measure the tendency for pesticides to be carried through the soil below the root zone. Pesticide movement ratings are based on two factors: persistence and mobility.

Persistence is a measure of the length of time the chemical remains active in the soil. OWQDA uses the chemical's half life to evaluate persistence. Chemicals with short half lives do not remain in the soil as long as chemicals with long half lives do.

Mobility is a measure of a chemical's tendency either to move through soil with leaching water or to be retained in the soil by sorption on particles of clay and organic matter. OWQDA uses the sorption coefficient, or Koc, to evaluate mobility. A high Koc value means a chemical has a strong tendency to bond to soil organic matter.

Chemical half life and Koc are combined into a single index number, the groundwater ubiquity score, or GUS for short. The range of GUS values is divided into six classes of pesticide movement ratings, ranging from extremely low to very high.

Soils at the low end of the scale tend to have very high Koc values and relatively short half lives. They pose very little risk of groundwater contamination. Chemicals rated high or very high tend to have longer half lives and low Koc values. Longer residence time combined with little tendency for these chemicals to bond with soil organic matter increases the risk of their being transported to groundwater.

Further information on the definitions of chemical properties, the derivation of GUS values, and the interpretation of pesticide movement ratings can be found in the following OSU Extension Service publications (see page 4 for ordering information):

- The OSU Extension Pesticide Properties Database, EM 8709
- Understanding Pesticide Persistence and Mobility for Groundwater and Surface Water Protection, EM 8561

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**Table 1. Groundwater vulnerability ratings.**

<table>
<thead>
<tr>
<th>Soil sensitivity rating</th>
<th>Extr. low</th>
<th>Very low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very high</th>
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<tr>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
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<tr>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Moderate</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
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<tr>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
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<tr>
<td>Very high</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
</tr>
</tbody>
</table>
Groundwater vulnerability ratings

Interactions between soil sensitivity ratings and pesticide movement ratings create the specific groundwater vulnerability ratings shown in Table 1. In general, chemicals with low pesticide movement ratings that are applied on soils with very low or low sensitivity ratings are very unlikely to reach groundwater. The corresponding groundwater vulnerability ratings are low.

Conversely, chemicals with high pesticide movement ratings applied on highly sensitive soils pose a real potential for transport through the soil to groundwater. These situations have high or very high groundwater vulnerability ratings.

Specific interpretations associated with each rating class are discussed below.

Very low—There is almost no chance that this chemical, when used on this soil, will contaminate groundwater, as long as the chemical is used according to label directions. The chemical does not tend to move in soils, and the soils do a good job of retarding chemical movement. This is the best possible situation for environmental protection.

Low—This soil-chemical combination poses a slight risk of groundwater contamination, as long as the chemical is used according to label directions. In most cases, the soil has a low or moderate sensitivity rating, and the chemical has a very low or low movement rating. Where soil sensitivity is higher, the chemical has an extremely low movement rating; where the chemical has a moderate movement rating, the soil sensitivity is very low or low. Thus, either soil properties or chemical properties can compensate for limitations that might be inherent in the other.

Moderate—This risk class arises either from particularly sensitive soils, or from high or very high pesticide movement ratings, or from intermediate levels of both soil sensitivity and pesticide movement. You can tell which particular combination leads to this result by looking at the separate ratings for soil sensitivity and pesticide movement.

In any case, the risk is with that, with careful use of the chemical and good crop and soil management practices, groundwater contamination is not likely. Nevertheless, a moderate vulnerability rating should trigger some additional evaluation of the overall management program to make sure that appropriate practices are and will be used.

High—Use of this chemical on this soil does present a potential problem for groundwater quality. The risk arises either because the soil has virtually no capacity to retard pesticide movement, or because the chemical is very mobile in the soil, or because both soil sensitivity and pesticide movement are rated high. The risk can be minimized, however, by conducting a thorough evaluation of all factors associated with the soil-crop-chemical management system, including the rate, method, and timing of chemical application, and whether or not alternative chemicals with lower pesticide movement ratings can be used.

Very high—This rating occurs only when a chemical having a high or very high pesticide movement rating is used on a soil with a high or very high sensitivity rating. Essentially, it means that a very persistent and very mobile chemical is used on a soil that has virtually no capacity to retard transmission of the chemical under a hydraulic loading sufficient to transport water and chemicals below the root zone. This represents a worst-case scenario under which there is a distinct possibility of groundwater contamination.

Even this rating, however, does not mean that this chemical cannot be used on this soil. But it does call for much more detailed analyses of the situation, taking into account all possible factors that affect the likelihood of groundwater contamination. It also requires the manager to develop and implement a precise set of management practices that, when implemented, will ensure that every possible effort is made to minimize the risk of groundwater contamination.

Management implications

As a first-tier screening tool, OWQDA accounts only for properties of the soil that enhance or retard chemical movement, and properties of the chemical that enhance or retard its persistence and mobility. This level of assessment is adequate to determine in general which combinations of soils and chemicals are quite safe to use, and which combinations are more likely to pose a problem. OWQDA does not account for factors such as application rate, method of application, or timing of applications in relation to irrigation or rainfall events.

For these reasons, a high or very high groundwater vulnerability rating does not necessarily mean that groundwater will become contaminated. Good water management, low chemical application rates, proper timing of applications, and careful handling of pesticides all compensate for high-risk situations. Conversely, low groundwater vulnerability ratings do not necessarily mean that groundwater cannot become contaminated, but the risk certainly is low as long as all label instructions are followed carefully.

Rate, timing, and method of chemical application are important management factors that influence groundwater vulnerability. Their assessment, however, enters into the
The decision-making process at a second or third tier of
screening and evaluation. This level of evaluation usually
is done only when considering specific management
practices for specific farms, fields, and crops, particularly
in circumstances where the Oregon Water Quality
Decision Aid has identified a soil-chemical combination
with a moderate or high risk.

Related OSU Extension materials

Determination of Soil Sensitivity Ratings for the Oregon
Water Quality Decision Aid, EM 8708, by
A detailed technical discussion of the development and
interpretation of the soil sensitivity ratings used in
OWQDA, including such factors as throughflow
potential, runoff potential, and hydraulic loading.

How Soil Properties Affect Groundwater Vulnerability to
Pesticide Contamination, EM 8559, by J.H. Huddleston
(1994). $1.00
A general introduction to the key factors involved in
determining a soil's leaching potential and sorption
potential. Explains the role of permeability, wet and dry
conditions, organic matter content, and clay content.

Introduction to the OSU Extension Soil Sensitivity Database,
EM 8707, by J.H. Huddleston, W.R. Mendoza,
A brief introduction to the key factors included in the
OWQDA soil sensitivity database, including
throughflow potential, runoff potential, and hydraulic
loading.

Oregon Water Quality Decision Aid Computer Software,
EM 8706, by J.H. Huddleston ($950). $25.00
Fully automated version of OWQDA, including the
complete pesticide properties database and the complete
soil sensitivity database.

The OSU Extension Pesticide Properties Database,
EM 8709, by P.A. Vogue, E.A. Kerle, and J.J. Jenkins
(1998). $2.50
Hard copy version of the pesticide database for using
OWQDA manually.

Hard copy version of the soils database for using
OWQDA manually. Order this publication from the
OSU Department of Soil Science (541-737-5712). There
is a nominal fee for photocopying and mailing.

Site Assessment for Groundwater Vulnerability to Pesticide
Contamination, EM 8560, by E.A. Kerle, P.A. Vogue,
J.J. Jenkins, and J.H. Huddleston (Revised 1998).
$1.50
Step-by-step instructions for using OWQDA manually
and worksheets for recording your data.

Understanding Pesticide Persistence and Mobility to
Groundwater and Surface Water Protection, EM 8561, by
A general introduction to the key factors involved in
determining the potential for pesticides to reach
groundwater and surface water. Explains the role of
photo-, chemical, and microbial degradation; sorption,
plant uptake, volatilization, and runoff, and
leaching.

How to order

To order copies of the above publications (except for
The OSU Extension Soil Sensitivity Database), or the
OWQDA computer software, send the complete title and
series number, along with a check or money order for the
amount listed, payable to Oregon State University, to the
address below. We offer discounts on orders of 100 or
more copies of a single publication title and for 12 or
more copies of a single computer software program. Please
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Order The OSU Extension Soil Sensitivity Database from
the OSU Department of Soil Science (541-737-5712).

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publications are available on the World Wide Web at
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