HydroSols

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Introduction

The hydromorphic process is developed in soils of different classes, giving them very particular characteristics. As it is well known, when the soil has reductive conditions, Mn and Fe solubilize, redistribute in the soil and, if the conditions change seasonally to a less reductive environments, accumulate forming certain types of oxides and hydroxides.

It is a program with educational purposes to introduce the students in the soil reduction/oxidation processes. This is an interactive computer programme for demonstration of macro and micromorphological aspects of hydromorphic processes in soils. This software belongs to a course developed for the soil-genesis teaching. Some computer other programs of this course are presented in this Eurosoil 2004: OpticalMine, Soil Microscopy, IlluviaSols and CO_3Sols.

The application

HydroSols has been re-worked using the heterogeneous (Windows, Mac, Linux, etc) languages HTML and JavaScript from a first version implemented in Hypertalk for Apple Macintosh computers, which was presented in the 10th International Working Meeting on Soil Micromorphology (Dorronsoro et al., 1996) and in the 16th World Congress of Soil Science (Dorronsoro et al., 1998).

The program is available in both English and Spanish versions and it can be found at:

http://edafologia.ugr.es/hidro/indexw.htm

HydroSols is a composed of texts, figures and microphotographs, the user will have to answer some questions concerning the identification of a mineral, which is shown in a picture. Thus, the software evaluates the knowledge of the student.

The presented software allows both the self-learning of the students and their self-evaluation. For the self-evaluation of the knowledge acquired by the student, test suite is provided. Additionally, the students can be calificated with this software; the highest score is 10 points and each wrong answer is penalized by two points (Figure 1).

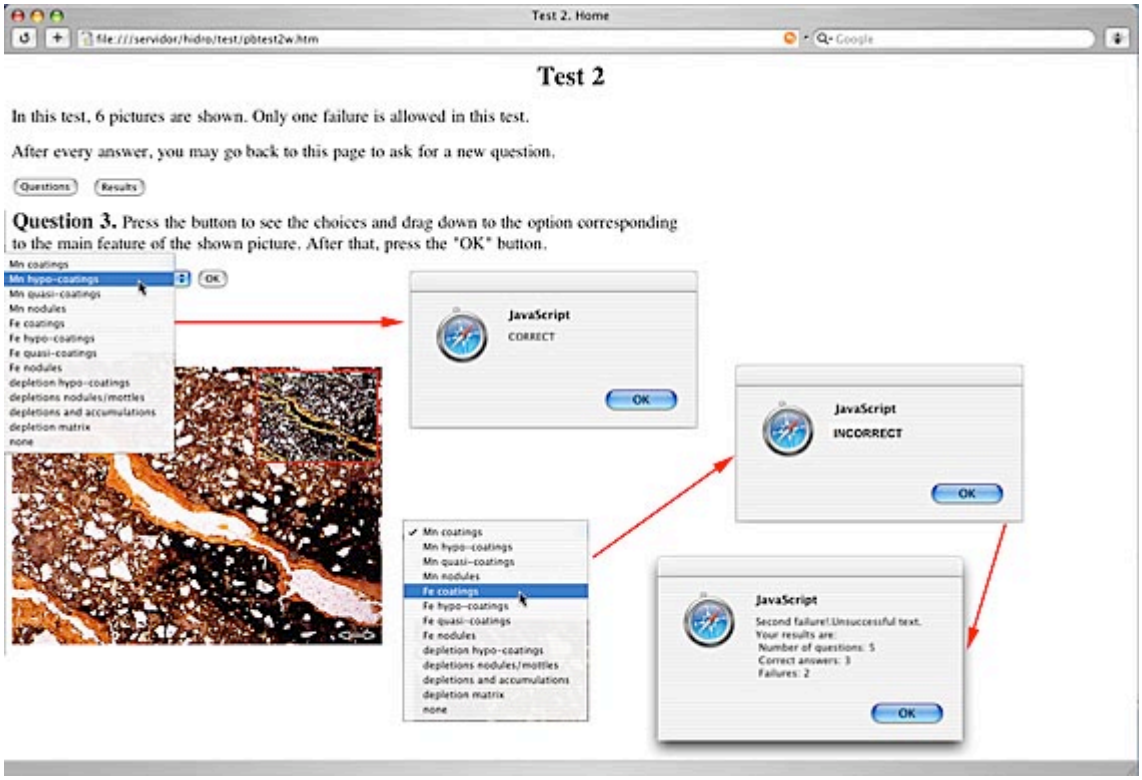


Figure 1. Test page.

Some scripts related to the Figure 1 are given below.

Script 1

```
<HTML>
<HEAD>
<TITLE>Test 2. Home</TITLE>
</HEAD>
<BODY>
<SCRIPT LANGUAGE="JAVASCRIPT">
var textPreg = " Questions: "
var textAciertos = "\r Correct answers: "
var textFallos = "\r Failures: "
var fallados = 0
var contador = 1
var nota = 10
var notificar = "\rMark: "
function WinOpen(nombre){
 open(nombre,"Window1","toolbar=no");
}
function empezar() {
   switch (contador)
            case 1: WinOpen("test1aw.htm");
            break
            case 2: WinOpen("test1bw.htm");
            break;
            case 3: WinOpen("test1cw.htm");
            break;
            case 4: WinOpen("test1dw.htm");
            break;
            case 5: WinOpen("test1ew.htm");
            break;
            case 6: WinOpen("test1fw.htm");
```

```
            break;
default:
alert("This test is finished.\rThe results are:\r" + textPreg + (contador -1)  + textAciertos + (contador - fallados - 1) + textFallos + fallados + notificar + nota);
}
//-->
</SCRIPT>
<!--/NOEDIT--></P>
<P><CENTER><B><FONT SIZE="+3">Test 1</FONT></B></CENTER></P>
<P><FONT SIZE="+1">In this test, 6 pictures are shown. Only one failure is allowed in this test.</FONT></P>
<P><FONT SIZE="+1">After every answer, you may go back to this page to ask for a new question.</FONT></P>
<P><input type="button"name="WindowButton" value= "Questions" onclick ="empezar()"></P>
<P> </P>
<P><input type="button" name="WindowButton" value="Results" onclick=
"alert(textPreg + (contador -1)  + textAciertos + (contador - fallados - 1) + textFallos + fallados + notificar + nota)"></P>
<P> </P>
<P> </P>
<P><CENTER> </CENTER></P>
<P><CENTER>
<A HREF="../testindew.htm"><FONT SIZE="+1">Index Test</FONT></A>
</CENTER>
</FORM>
</BODY>
</HTML>
```

Script 2.

```
<HTML>
<HEAD>
 <TITLE>Test 2. Question 3.</TITLE>
</HEAD>
<BODY BGCOLOR="#ffffff">
<P><!--NOEDIT-->
<SCRIPT LANGUAGE="JAVASCRIPT">
  function ChecFallos() {
    if (fallados>=2) {
      alert("Second failure!.\rUnsuccessful test.\rYour results are:\r" + textPreg + contador  +
  textAciertos + (contador - fallados) + textFallos + fallados);
      fallados=0;
      contador=0;
  }
function DisplayItem (IstOption){
var i = IstOption.selectedIndex;
if (i==1)
{ alert("CORRECT"); self.close();}
else{alert("Incorret");
self.close();window.opener.fallados=window.opener.fallados+1;window.opener.ChecFallos();
window.opener. nota=window.opener. nota-2 ;}
}
function pulsado(IstOption){
if (window.opener.contador==3)
 {
DisplayItem(IstOption)
window.opener.contador=window.opener.contador+1
}
else self.close()
}
</SCRIPT>
```

```
<!--/NOEDIT--></P>
<P ALIGN=CENTER><B><FONT SIZE="+3">Test 2</FONT></B></P>
<P><B><FONT SIZE="+2">Question 3. </FONT></B><FONT SIZE="+1">Press the button to see the choices and drag down to the option corresponding to the main feature of the shown picture. After that, press the &quot;OK&quot; button.</FONT></P>
<P><!--NOEDIT-->
<FORM>
<SELECT NAME="IstOption">
<OPTION SELECTED>Mn coatings
<OPTION>Mn hypo-coatings
<OPTION>Mn quasi-coatings
<OPTION>Mn nodules
<OPTION>Fe coatings
<OPTION>Fe hypo-coatings
<OPTION>Fe quasi-coatings
<OPTION>Fe nodules
<OPTION>depletion hypo-coatings
<OPTION>depletions nodules/mottles
<OPTION>depletions and accumulations
<OPTION>depletion matrix
<OPTION>none
</SELECT>
<INPUT TYPE= "button" VALUE= "OK" onclick= "pulsado(this.form.IstOption);">
</FORM>
<SCRIPT LANGUAGE="JAVASCRIPT">
document.write ("The number of questions is: " + (window.opener.contador - 1))
document.write ("<P>The number of failures is: " + window.opener.fallados)
</SCRIPT>
<!--/NOEDIT--><p></P>
<P><IMG SRC="../media/test2c.gif" WIDTH="400" HEIGHT="300" ALIGN="BOTTOM"
NATURALSIZEFLAG="3">
</BODY>
</HTML>
```

The program has 146 pages with 149 pictures, which a size of 23.8 MB.

A specific high-security navigator (soile v.1.0) has been developed to examine students; our navigator does not allow some non-desired options of usual navigators (navigator menu, refresh of the current page, access to the source code, access of the history of visited pages, etc), and it provides automatic recording of the results.

The programme covers five points.

INTRODUCTION, considering the processes of oxidation/reduction and the conditions necessary (Figure 2).

MICROFEATURES: accumulation and depletion pedofeatures are described and their respective conditions of formation analyzed.

MICROPROFILES, explaining the vertical sequences of features at a micro-scale level.

STAGES, evaluating the degree of hydromorphism in soils, and distinguishing five levels of intensity (Figure 3).

PALEOHYDROMORPHISM, indicating which features are most characteristic to differentiate between present day hydromorphism and ancient hydromorphism.

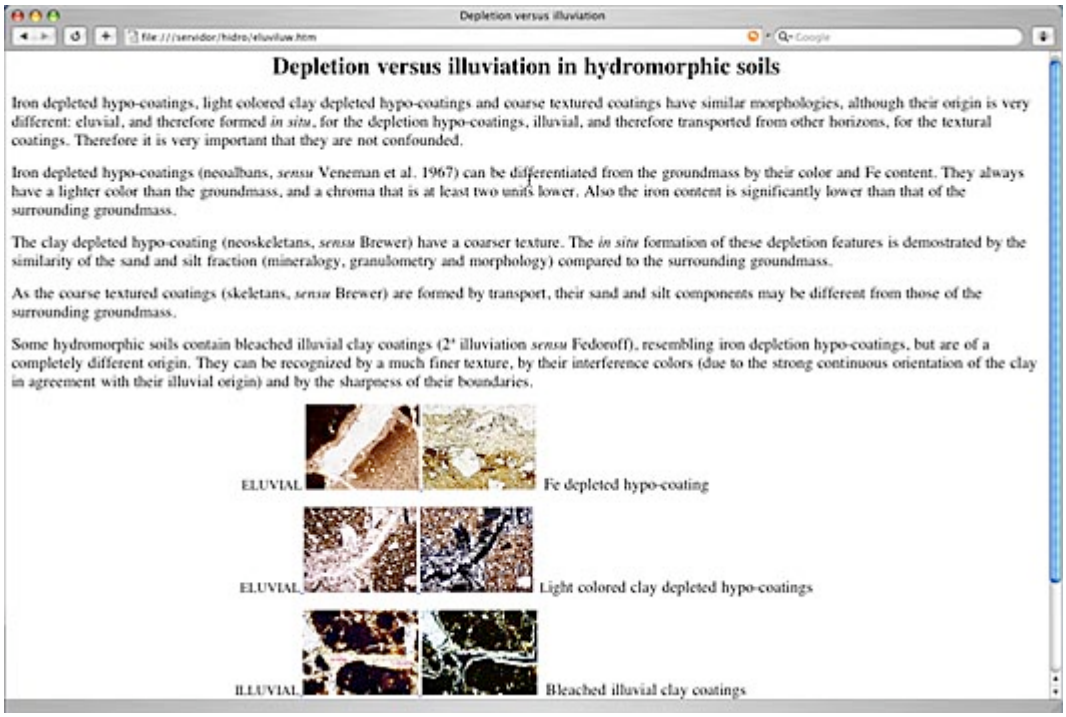


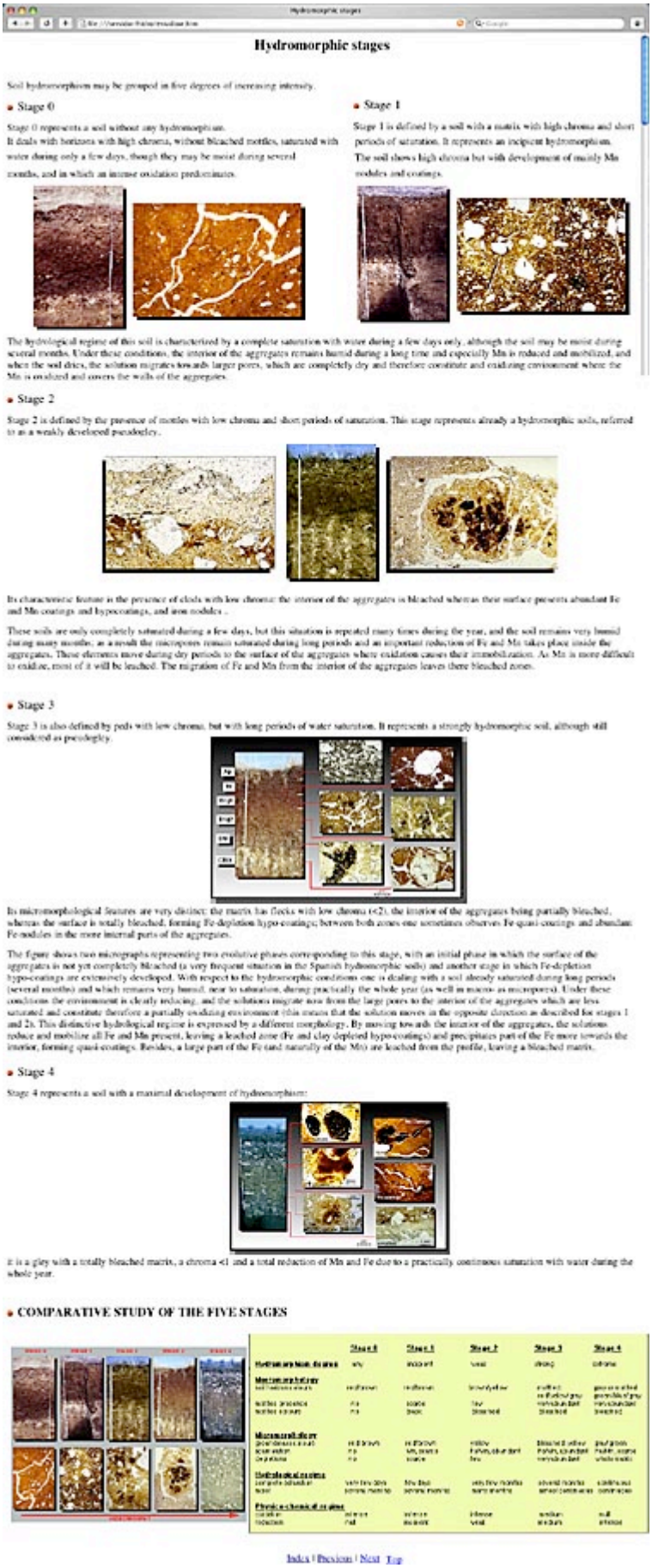
Figure 2. Depletion versus illuviation page.

Didactic evaluation

The program has been evaluated by a group of students and the results are summarized in Table 1. The evaluation reveals the high acceptance and the good marks obtained, so the method is considered as highly effective.

Acceptance by the student	
Evaluation of the practices	
Very satisfied	62 %
Satisfied	28 %
Acceptable	6 %
Disagreement	3 %
Very disagreement	0 %
No opinion	1 %
Attainment of objectives	
Totally	48 %
Enough	22 %
Sufficient	23 %
Scarce	5 %
Null	0 %
No opinion	2 %
Marks obtained	
First class	34 %
Second class	23 %
Pass	31 %
Fail	12 %
Population	187 students

Table 1. Results of the evaluation test made by the students.



Hydromorphic stages

Hydromorphic stages

Soil hydromorphism may be grouped in five degrees of increasing intensity.

- Stage 0

Stage 0 represents a soil without any hydromorphism.
It deals with horizons with high chroma, without bleached mottles, saturated with water during only a few days, though they may be moist during several months, and in which an intense oxidation predominates.

- Stage 1

Stage 1 is defined by a soil with a matrix with high chroma and short periods of saturation. It represents an incipient hydromorphism.
The soil shows high chroma but with development of mainly Mn nodules and coatings.

The hydrological regime of this soil is characterized by a complete saturation with water during a few days only, although the soil may be moist during several months. Under these conditions, the interior of the aggregates remains humid during a long time and especially Mn is reduced and mobilized, and when the soil dries, the solution migrates towards larger pores, which are completely dry and therefore constitute and oxidizing environment where the Mn is oxidized and covers the walls of the aggregates.

- Stage 2

Stage 2 is defined by the presence of mottles with low chroma and short periods of saturation. This stage represents already a hydromorphic soils, referred to as a weakly developed pseudogley.

Its characteristic feature is the presence of clods with low chroma: the interior of the aggregates is bleached whereas their surface presents abundant Fe and Mn coatings and hypocoatings, and iron nodules ..

These soils are only completely saturated during a few days, but this situation is repeated many times during the year, and the soil remains very humid during many months, as a result the micropores remain saturated during long periods and an important reduction of Fe and Mn takes place inside the aggregates. These elements move during dry periods to the surface of the aggregates where oxidation causes their immobilization. As Mn is more difficult to oxidize, most of it will be leached. The migration of Fe and Mn from the interior of the aggregates leaves there bleached zones.

- Stage 3

Stage 3 is also defined by peds with low chroma, but with long periods of water saturation. It represents a strongly hydromorphic soil, although still considered as pseudogley.

Its micromorphological features are very distinct: the matrix has flecks with low chroma (<2); the interior of the aggregates being partially bleached, whereas the surface is totally bleached, forming Fe-depletion hypo-coatings; between both zones one sometimes observes Fe quasi-coatings and abundant Fe-nodules in the more internal parts of the aggregates.

The figure shows two micrographs representing two evolutive phases corresponding to this stage, with an initial phase in which the surface of the aggregates is not yet completely bleached (a very frequent situation in the Spanish hydromorphic soils) and another stage in which Fe-depletion hypo-coatings are extensively developed. With respect to the hydromorphic conditions one is dealing with a soil already saturated during long periods (several months) and which remains very humid, near to saturation, during practically the whole year (as well in macro- as micropores). Under these conditions the environment is clearly reducing, and the solutions migrate now from the large pores to the interior of the aggregates which are less saturated and constitute therefore a partially oxidizing environment (this means that the solution moves in the opposite direction as described for stages 1 and 2). This distinctive hydrological regime is expressed by a different morphology. By moving towards the interior of the aggregates, the solutions reduce and mobilize all Fe and Mn present, leaving a leached zone (Fe and clay depleted hypo-coatings) and precipitates part of the Fe more towards the interior, forming quasi-coatings. Besides, a large part of the Fe (and naturally of the Mn) are leached from the profile, leaving a bleached matrix.

- Stage 4

Stage 4 represents a soil with a maximal development of hydromorphism:

it is a gley with a totally bleached matrix, a chroma <1 and a total reduction of Mn and Fe due to a practically continuous saturation with water during the whole year.

- **COMPARATIVE STUDY OF THE FIVE STAGES**

	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Hydromorphic features					
Macromorphology					
Micromorphology					
Hydrological regime					
Physico-chemical properties					

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Figure 3. Hydromorphic stages page.

References

BULLOCK, P.; FEDOROFF, N.; JONGERIUS, A.; STOOPS, G. y TURSINA, T. 1985. Handbook of soil thin section description. Waine Research Publishing, Albrighton, U.K.

DORRONSORO, C. ; FERNANDEZ, J.; AGUILAR, J. 1996. Interactive computer programme for demonstration of micromorphological aspects of the process of hydromorphy in soils. 10th Int. Working Meeting on Soil Micromorphology. Moscow. Russia.

DORRONSORO, C.; FERNANDEZ, J.; AGUILAR, J.; STOOPS, G. 1998. Hydromorphic soils. 16th World Congress of Soil Science. Montpellier. France.