

Designing a Public Web-Based Information System to Illustrate and Disseminate the Development and Results of the DESIRE Project to Combat Desertification

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Received: 10 July 2012 / Accepted: 3 May 2013
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Abstract Until around 1995 it was challenging to make the scientific results of research projects publicly available except through presentations at meetings or conferences, or as papers in academic journals. Then it began to be clear that the Internet could become the main medium to publish and share new information with a much wider audience. The DESIRE Project (desertification mitigation and remediation of land—a global approach for local solutions) has built on expertise gained in previous projects to develop an innovative online ‘Harmonized Information System’ (HIS). This documents the context, delivery and evaluation of all tasks in the DESIRE Project using non-scientific terminology, with much of it also available in the local languages of the study sites. The DESIRE-HIS makes use of new possibilities for communication, including video clips, interactive tools, and links to social media networks such as Twitter. Dissemination of research results using this approach has required careful planning and design. This paper sets out the steps that have culminated in a complete online Information System about local solutions to global land management problems in desertification-affected areas, including many practical guidelines for responsible land management. As many of those who are affected by desertification do not have Internet access, printable dissemination materials are also available on the DESIRE-HIS.

Keywords Information · Dissemination · Website · Knowledge management · Stakeholders · Sustainable land management · Land degradation

Introduction

A large number of scientific research projects in the field of desertification have been undertaken globally during the last 30 years, including many funded by the European Commission (EC). These projects have provided a better understanding of the physical processes of desertification, including ways to reduce its impacts. Although a great deal of knowledge has been gained, communication and application of that knowledge has been relatively slow, for various reasons. There are many opportunities for a more sustainable use of global natural resources, but effective communication and dissemination strategies are required in order to maximize the impact and value of scientific findings. It is good that dissemination of results has now explicitly become a contractual obligation of participation in all EC Framework Program research projects (Official Journal of the European Union 2006). However, there is a growing consensus that more will be required in the future to increase the impacts of research projects through greater dissemination and exploitation of knowledge generated (European Commission 2012; United Nations Convention to Combat Desertification [UNCCD] 2010). Knowledge generated includes both tangible and intangible results of research projects; informative literature and training material, but also changes in attitude, increased awareness, and improved knowledge and skills for end-users. Improved knowledge management, defined as “recognizing the relationship between the knowledge of one individual or actor and that of others, and, from there, starting

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to negotiate knowledge for joint purposes—to redefine it, codify it, combine and integrate it, accept or exclude specific knowledge for specific purposes” (Bruckmeier and Tovey 2008) will help to improve decision-making and confer greater resilience to such changes.

Desertification is defined by the UNCCD (1994) as “land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities”. Desertification is a subset of land degradation processes, under dry climates. Combating desertification subsequently “includes activities which are part of the integrated development of land in arid, semi-arid and dry sub-humid areas for sustainable development and which are aimed at: the prevention and/or reduction of land degradation; the rehabilitation of partly degraded land; and the reclamation of desertified land” (UNCCD 1994). Desertification is a complex issue because of the interplay between socio-cultural, economic and biophysical factors (such as climatic variations) (Millennium Assessment 2005; Reynolds and others 2011; Hessel and others, this issue). Since it threatens the livelihoods of millions it is also very serious, and needs to be kept in the public eye (UNCCD 2012). Although the UNCCD has been in operation since 1994, desertification often remains misunderstood and a low priority for action. The understanding of desertification has shifted from a primarily physical appraisal, to an acceptance that human actions (for example, those that limit protective vegetation cover and allow increased erosion by wind and water) play a large part in the appearance of most landscapes (Stringer 2006). This shift has been accompanied by an increased awareness that desertification can only be solved in collaboration with the communities affected by it; thus the need to collaborate with stakeholders and to inform them about research results must be emphasized (Reed and others 2013).

Incorporated in the design of the EC-funded DESIRE Project “Desertification mitigation and remediation of land—a global approach for local solutions” (2012) was a strong intention to ensure that research was “user-inspired, user-friendly and user-useful” in line with contemporary thinking (Aronson and others 2010). DESIRE focused on combating desertification with an interdisciplinary approach, combining a wide range of research perspectives. DESIRE chose an interactive style of development in which researchers and practitioners collaborated in research achievements so that the “fruits of research are combined with the understanding and skills of professional practitioners” (Huberman 1994). To ensure its research findings were user-friendly and user-useful, DESIRE tailored its methods of information-sharing to be accessible to a range of different types of users with varying levels of expertise (technical, practical and technological), ranging from the academic community to farmers and other land-

managers and the general public. Feedback was also collected from the users, so that the quality and usefulness of information could be optimized. Information technology now provides many new opportunities to share messages with a wide range of people: of all ages, interests and disciplines. Communication about research findings no longer has to be principally one way, since instant multi-party/stakeholder feedback is now possible, especially via email and other electronic messaging formats. Of course not everyone has online accessibility; and often not those land users in developing countries that are worst affected by desertification. Therefore, the DESIRE Project developed the DESIRE-Harmonized Information System (HIS, 2012a) for those who have Internet access, and developed printable dissemination materials for manual distribution to those who do not. The range of stakeholders envisaged when the DESIRE Information System was first launched included other researchers, land users and policy makers, and representatives from these groups were invited to participate in project workshops. In the planning of the workshops, it was important to ensure that products of interest to specific groups were included, and made available in accessible formats and language.

This paper describes how communication and dissemination opportunities have expanded in line with advances in information technology. First we review the development of ideas in past projects. Then we explain why the DESIRE-HIS was required and how it was developed to house the research results from DESIRE, and to provide dissemination material for a wide range of stakeholders. During the website development a number of lessons were learned, responding to feedback from both researchers and the wide range of stakeholders. From this we are able to make recommendations for future communication and dissemination priorities in our conclusions.

Background to Providing an Information System

The Importance of Making Information Accessible to Support the Long-Term Uptake of Measures to Combat Desertification

In the 1990s many projects were funded to research scientific questions, but active dissemination to a wider audience was not necessarily supported as part of the project itself. Then gradually projects such as Mediterranean Desertification and Land Use (MEDALUS III Project, 1999) began to focus on helping stakeholders to use the scientific results, and allowing interaction of various knowledge and ideas (Kosmas and others 1999). Recent and contemporary projects (e.g. LADAMER Project 2002–2005; DESURVEY Project 2005–2010; PRACTICE

Project 2009–2012; UNDESERT Project 2010–2015) have now realized the importance of participatory decision-making and other bottom-up approaches that involve stakeholder groups and the public in combating desertification. Details of such European research can be found on the DESIRE-HIS (2012b). A model for sustainable land management has been developed that is less hierarchical and coming from targeted groups (such as stakeholders and local populations) rather than solely from actors in the policy process and scientific discourse (Bruckmeier and Tovey 2008).

The Development of Online Information About Land Degradation and Desertification in Previous Initiatives

Although the importance of long-term support and advice based on contemporary research has been recognized as cost-effective, few programs (e.g. Adoption of soil and water conservation measures in southern Mali, Bodnár and others 2006) have found the financial resources to organize long-term physical support to stakeholders from researchers or extension workers. Publicly accessible websites and online tools therefore often represent a more achievable option for providing support. To enhance the operational use of material derived from scientific programs, projects in the EU's Framework Program 5 such as MEDACTION Project (2004), DESERTLINKS Project (2005), and LADAMER Project (2002–2005) were among the first to make considerable progress in developing instruments that were of direct use for policy makers, planners and managers in desertification-affected areas.

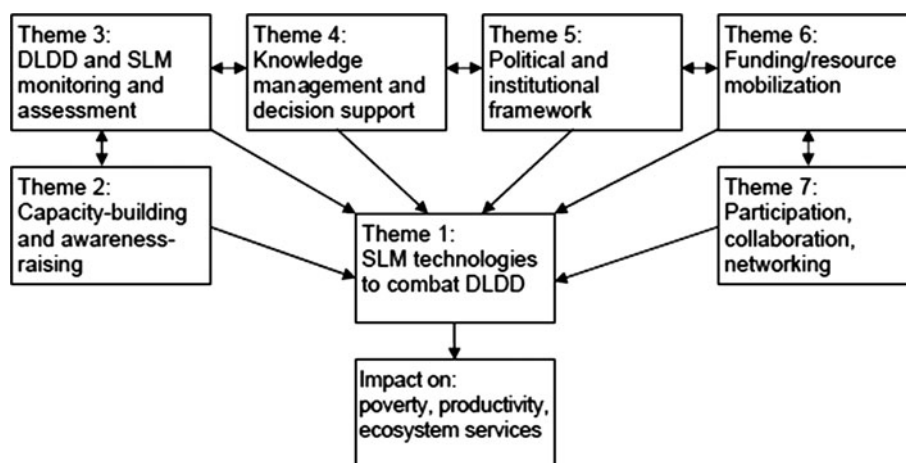
Between 2000 and 2005 the first initiatives to provide Internet-based data and information services became publicly available online, in projects such as DESERTLINKS Project (2005), DISMED Project (2005), CLEMDES Project (2005), and from earlier versions of the UNCCD website (2012). These were all successful in the individual objectives they undertook, but they were restricted by a finite timeframe and, following project completion there was a lack of funding mechanism for future updates. CLEMDES Project (2005), a Clearing House Mechanism on Desertification for the Northern Mediterranean Region set up an Internet-based information facility that could be used at national level in national languages. The website included forms that could be completed by users to add details of experts and projects on desertification, meetings, workshops and other news. However, as the CLEMDES information facility relied on the motivation of users to upload their own data and information, the information outputs were disappointingly limited. DISMED Project (2005), a Desertification Information System for the Mediterranean concentrated on reinforcing communication between Mediterranean countries, also holding international technical workshops on

information needs (DISMED Project 2005). Since then workshops for researchers and a wide range of stakeholders have become more widely used as an effective way of focusing on problems and arriving at consensus on both desertification priorities and the organization of available information (DESERTLINKS Project 2005; Schwilch and others 2013).

DESERTLINKS Project (2005) was one of the first projects to develop a website specifically dedicated to the organization and dissemination of research about desertification (DIS4ME [DESERTLINKS Project] 2005), rather than simply a website providing project information. DIS4ME gives access to some 148 indicators of relevance to Mediterranean desertification. It was designed to provide a tool to enable users from a wide range of backgrounds, including scientists, policy makers and farmers to identify where desertification is a problem, assess how critical the problem is, and to better understand the processes of desertification. Following on from this, LUCINDA Project (2008) synthesized the results of some 27 preceding EU-funded projects to provide comprehensive information packs on desertification in non-scientific language, all available to download from a dedicated website. LUCINDA booklets, leaflets and PowerPoint presentations were developed to provide guidelines on sustainable land management to a wide range of users, including policy makers.

Recently, there have been renewed calls for improved access to scientific research and the provision of research results in formats accessible for land users and policy makers. This had not been undertaken previously on a common global basis, and so the UNCCD (2009) has sought to highlight the determination and dissemination of good or best practices. To achieve this, the UNCCD proposed a knowledge-sharing system, with a global database, based on seven themes as shown in Fig. 1. This incorporated ideas proposed by the WOCAT (World Overview of Conservation Approaches and Technologies 2012) approach to documenting sustainable land management (SLM) technologies to combat desertification, land degradation and drought (DLDD) that have since been further developed and extended in the DESIRE Project (Schwilch and others 2013). DESIRE-HIS has responded to the UNCCD's information needs by describing and illustrating WOCAT's methodology to select good practices in terms of approaches and technologies, and demonstrating how this methodology has been implemented in the DESIRE study sites (DESIRE-HIS 2012c; Schwilch and others 2012). The UNCCD (2010) has also published a Comprehensive Communication Strategy and DESIRE-HIS supports communication of the main UNCCD messages: to prevent and mitigate desertification with sustainable land management practices.

Fig. 1 Interactions between themes and the impact of the themes on the goals of the United Nations Convention to Combat Desertification (2009) (permission to reproduce this figure received 9 July 2012, with the disclaimer that although this proposal was not fully endorsed by the CRIC and the COP, COP10 in 2011 did take a decision on classification of themes of best practices and their interlinkages)



In 2010, the UNCCD held a scientific conference where a series of White Papers were presented, representing the combined expertise from key research. Material from the White Papers was subsequently compiled within a special issue entitled “Understanding dryland degradation trends”, in *Land Degradation and Development* (Winslow and others 2011; Reed and others 2011) to provide a comprehensive review of past research and future needs. More recently, the UNCCD (2012) has focused on the need to achieve a zero net-growth in land degradation. Raising public awareness with enhanced participation and communication will form a key part of this.

Stakeholders and Other Recipients for Dissemination Products

The full potential of research projects can only be realized if recommendations are received, accepted and adopted/implemented by stakeholders. A broad definition of stakeholders includes all those who are affected by an issue or process, or who have the power to influence issues and processes. In the context of desertification, stakeholders may range from families who depend upon and manage the land, to the policy makers at district, national and international levels who design and implement policies and regulations. Therefore, research projects need to develop a pragmatic approach to communicate the findings effectively to diverse stakeholder groups (Reed and others 2007, 2013; Geeson and Reed 2011).

By working closely with those people who require the information, it is possible to better understand their needs and how best to communicate effectively with them. It is also important to target individuals and groups who are likely to act on new information, either to use it themselves or to pass it on to others. Key pieces of information may be assembled in different combinations or formats for different purposes and groups of people. However, there are limits to

the volume of dissemination materials that can realistically be produced from a project. It is not possible to address all stakeholders individually, but it is important that some information of relevance can be provided. It is a challenge to keep research results organized in such a way that access to all information remains simple to find and use.

Stakeholders identified in research projects such as DESIRE often have a wide range of needs and interests. Individually they may be interested in only a few parts of the project rather than the full spectrum of results. Where possible, stakeholders should be given the opportunity to access the information provided at a level of detail that is most suitable for them. It is not necessary to pre-judge or generalize the preferences of specific groups (Geeson and Reed 2011). Some stakeholders may prefer to be shown pictorial information, while others will be happy using the Internet themselves and may include English (the standard language of scientists) in the languages they can read. Within an online information facility, it is logical to make a graduation from simple to more complex information, so that users can drill down into the content as far as their interest takes them.

Since it often takes time for stakeholders such as land users to understand and trust new ideas for sustainable land management technologies, there are additional benefits in providing information in various forms and maintaining a website to provide easily accessible long-term support. Schwilch and others (2009) noted that agricultural advisors supporting land users need a source of ideas backed-up by reliable scientific research. From another perspective, Bodnár and others (2006) described the value of researchers involving extension staff to improve the adoption rates of sustainable land management options, but they also identified that this was difficult to sustain after a project ended. Therefore, a website such as DESIRE-HIS can be an enduring and cost-effective method of providing support information in a range of formats.

Dissemination in the DESIRE Project

The goal of the DESIRE-HIS was to organize, showcase and disseminate the project results, presenting them in such a way that there was a clear narrative linking all the research elements together, and arriving at the final conclusions and policy recommendations. The content was to be written so that material previously limited to the research community was accessible to a range of stakeholders with different levels and types of expertise. Now the project has ended, the completed DESIRE-HIS website will remain accessible online and can therefore endure as a reference point to promote practical sustainable land management in drylands.

At the start of the project, a preliminary list of stakeholder groups from global to local levels was assembled, and various stakeholder checklists were consulted to improve inclusivity. A manual of communication and dissemination was assembled to help DESIRE partners identify and include a wide range of relevant stakeholders in the research within each study site (Geeson and Reed 2011). In general, the main groups of stakeholders for whom the DESIRE-HIS would be designed were likely to be: (i) other researchers engaged in combating land degradation and desertification, particularly in relation to the UNCCD (2012); (ii) land users in DESIRE Project study sites and other areas with similar issues; (iii) policy makers who need clear and concise summaries of scientific research in order to make well-informed decisions. Then detailed assessment using the WOCAT (WOCAT 2012; Schwilch and others 2012) methodology was used to identify, group and prioritize stakeholders according to the objectives of DESIRE. WOCAT questionnaires and workshop methodology promote dialog, mutual understanding, and agreement on sustainability or conservation goals.

In order to meet the challenge of providing something for everyone, the DESIRE approach was to provide information at up to three levels of complexity: simple, middle-range and advanced where appropriate (Geeson and Reed 2011). A checklist (Fig. 2) was designed (Geeson and Reed 2011) to match the likely needs of the stakeholder audiences to dissemination products, as a further prompt to providing suitable dissemination products.

A series of procedural steps were also identified (Geeson and Reed 2011) that would result in the provision of information in formats to suit the range of DESIRE stakeholders:

- (1) Identify the range of key stakeholder groups,
- (2) Identify the complexity of information required by key stakeholder groups (ideally by asking the stakeholders directly),
- (3) Identify the ideal formats for information suitable for key stakeholder groups,
- (4) Choose the most relevant of all the messages coming out of the research, to address the particular stakeholders,

These factors were used for deciding what information was included in dissemination products. The next stages were about how this information could be used,

- (5) Assemble packages of information from the research results, or adapt this material for specific stakeholder groups,
- (6) Determine what needs to be translated into the local language,
- (7) Plan the use of the packages for key stakeholder groups and other suitable stakeholders,
- (8) Adapt these packages for other peripheral groups of stakeholders,

Fig. 2 A checklist for defining audience expectations (Geeson and Reed 2011)

Defining audience expectations	
1. Are the audience researchers or scientists?	
- Yes:	Use fully referenced scientific research papers, plus material suitable for a literate audience (<i>advanced and mid-range complexity</i>)
- No:	Go to 2
2. Is the audience literate?	
- Yes:	Go to 3
- No:	Use oral presentations, plus pictorial and video material to convey explanation and instruction (<i>simple complexity</i>)
3. Will the audience expect technical detail?	
- Yes:	Go to 4
- No:	Use less detailed explanations, less text and more visual material (<i>simple and mid-range complexity</i>)
4. Will technical detail be used for decision-making at higher than local level?	
- Yes:	Use clear concise explanation or instructions or policy briefs (<i>advanced and/or mid-range complexity</i>)
- No:	Use explanations or instructions suited to local conditions (<i>mid-range complexity</i>)

- (9) Determine the best ways (using participatory methods) for dissemination to happen: face to face, at meetings, with printed products, by email or online through the DESIRE-HIS, e.g., using exhibitions, community events, social events, conferences, TV interviews, podcasts, videos, DVDs, other written material, etc.,
- (10) Put these plans and preparations into practice.

The messages for dissemination from DESIRE covered not only research results but also lessons learned in the research procedure, including interactions with stakeholders.

Design and Development of the DESIRE-HIS

Design of the DESIRE-HIS

The DESIRE consortium decided that the Information System needed to serve several purposes. First of all, it was a framework to house research from the project partners.

Fig. 3 The sequence of four Phases of DESIRE Project research common to all study sites. When viewed online a choice of further information is revealed under each illustration (DESIRE-HIS 2012d)

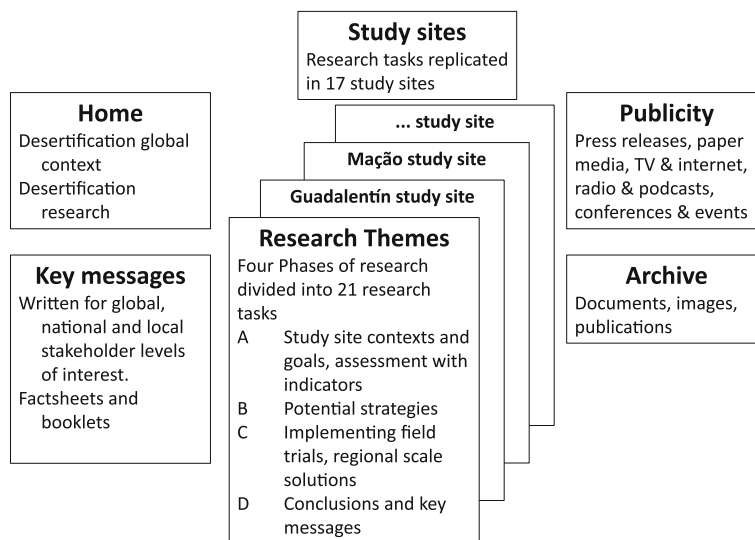
Research themes overview

The research themes are linked in a four-phase methodology that is replicated in each study site.



Photographs, videos and other support material such as local newsletters could also be shared. Gradually, as more results became available the focus would shift towards an audience outside the project, who would need explanation in non-scientific language in order to take practical actions. The material would be shown in English, but also in languages local to the study sites where possible. In that way it would include research information of interest to each study site, accessible all in one place for local viewers. If communication and dissemination have been efficient, there is a good chance that the stakeholders who stand to benefit from the research will carry on using what they have learned, and will share their knowledge with new contacts.

DESIRE followed a sequence of research steps to determine “local solutions to global sustainable land management problems” (Hessel and others, this issue). Figure 3 shows how four phases of research were used to portray and link information on the DESIRE-HIS (2012d). A similar sequence of research was carried out in each of the 17 DESIRE study sites, and therefore Fig. 3 could be used as a common format for an information directory or hub for each site.

Fig. 4 Schematic organization of the DESIRE-HIS

The sections of the website are based on the structure of the project, as shown in Fig. 4. In this way different groups of people can easily find information suited to their interests, either primarily about the development of the science or focused on the geographical locations.

As each step of DESIRE research was completed, research and study site leaders were asked to supply text to fill introductions and links within and between web pages. All project partners were encouraged to use various types of media to communicate with stakeholders in the study sites, such as video, podcasts, PowerPoint presentations and newsletters, and to also make these available on the DESIRE-HIS. Where appropriate the items were provided in study site languages as well as in English.

Using the website's section, category and article level structure, information is presented at increasing levels of detail, from basic overviews and summaries to full scientific reports (Fig. 5).

On the main menu of DESIRE-HIS a Home page (2012a) gives an overview of the project and a Guided Tour so that users can quickly understand the breadth of information available. The menus direct the reader to full coverage of project activities, provided from a wide range of perspectives, for a wide range of users.

Dissemination Products on the HIS

The provision of information at different levels of complexity for different users may be illustrated by visiting the DESIRE-HIS section on field experiments. For example, for the Mação study site in Portugal, brief summary information is provided in simple language with diagrams about how preventive forestry can avoid the incidence of damaging forest fires. This is followed by the opportunity

to download and read a poster with more detail, or download the full scientific details of the site implementation plan (DESIRE-HIS 2012e). A link to the same type information for other study sites, or the context of field experiments in all sites is also offered.

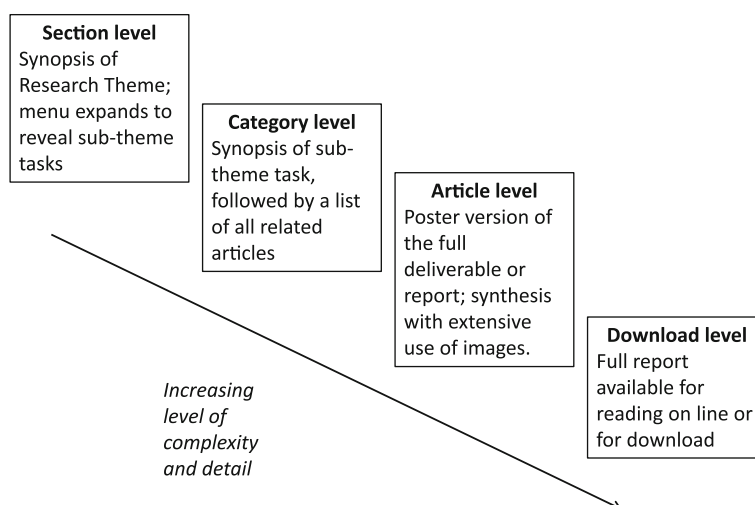
The same approach is taken when describing the sequence of research. For example, the aims of the workshops following WOCAT methodology (2012) are described briefly in simple terms, followed by a more-detailed list of steps to be followed. Readers also have the option of accessing more information about individual study sites or downloading articles in more scientific language from a list, in this case details about the methodology as well as a synthesis of results.

The Key Messages from DESIRE-HIS (2012f) have been collected together under one heading for those who are more interested in the recommendations than the research details (Fig. 6). This includes collected material of interest to user groups at different geographical scales from local to global. Video is acknowledged to be one of the most powerful and all-encompassing communication formats, and is therefore used to provide an overview of the project. All short documents are presented in an online reading format as well as being downloadable. Since the stakeholders include national policy makers as well as researchers and individual farmers, the messages are signposted accordingly.

At the global level DESIRE has supported the UNCCD with contributions to all key initiatives since 2008, in particular to the White Papers at the first scientific conference at COP9/CRIC8 in 2009. At UNCCD COP10 in 2011 DESIRE research addressed the 10 year plan strategic objective 2, and provided three briefing notes:

- “DESIRE and zero net-growth in degradation” (topic under discussion at Rio+20, see UNCCD 2012),

Fig. 5 The DESIRE-HIS provides information at increasing levels of complexity and detail



- “Engaging with people affected by desertification” (in collaboration with the INVOLVED Project 2011),
- “Putting knowledge into action” (DESIRE recommendations).

The DESIRE Factsheet series was made with a view to clarifying the reasons why it is important for researchers to involve stakeholders in their work. The Factsheets were written from various perspectives: for researchers, policy makers and stakeholders. In addition, the DESIRE Infobrief series covered a variety of themes, all written in non-scientific language, often in response to project events, including the following titles:

- “Tackling salinization of soils in arid and semi-arid regions” (combining research findings from the Russian and Greek study sites)
- “Sustainable land management enhances our soils” (written to support the UNCCDs Desertification Day 2010),
- “Scientists and stakeholders learn to listen to one another” (using outcomes of stakeholder workshops in the DESIRE study sites),
- “Using land for the benefit of all” (an overview of WOCAT methodology for stakeholder workshops to achieve sustainable land management),
- “Harnessing communication media” (lessons on sharing research messages from the DESIRE Project),
- “Manual of communication and dissemination” (a generic 57 page manual communication methodology and recommendations, as used in DESIRE: Geeson and Reed 2011).

Feedback from stakeholders was integrated into dissemination products where appropriate. In Turkey stakeholders from one site were taken to visit a second site, to exchange experience. Two leaflets were compiled about this event, each in English and in Turkish. The first

included details of the field trials, and the second was much simpler, mainly pictorial. This was an example of how research material was developed and disseminated at more than one level of complexity, to suit the recipients. The simpler leaflet was given to the farmers and their families as a memento of their visit, and was also circulated to local newspapers (DESIRE-HIS 2012g).

In Botswana and Cape Verde interviews with local residents about their perceptions of desertification in their area and the impact of the DESIRE research were recorded on video, and these video clips can be viewed on the DESIRE-HIS (2012h). To hear local people talk about addressing local issues is a powerful way of engaging the interests of their neighbors. In addition, discussions in Botswana at a high level meeting of researchers with national media (TV, radio, printed paper) were reported (DESIRE Project 2011). Again the language used to describe DESIRE research was adjusted to suit the recipients. Both researchers and media representatives were very enthusiastic about this meeting and concluded that they could do more in the future, both to communicate with one another, and to communicate with the wider world.

A major aim of the DESIRE-HIS was to share the details of successful sustainable land management practices with other land users with similar issues outside the DESIRE study site. Therefore, for every site details of the experiments, their results, and an assessment of their cost-effectiveness were provided. For example, in the Guadalentín study site, Spain, a series of newsletters in Spanish (DESIRE-HIS 2012i) and a slide presentation, Los Alhagüeces (DESIRE-HIS 2012j) were used to demonstrate the benefits of green manure and mulches in almond orchards over a wider area.

A second major aim was to provide guidance for policy makers needing to make informed decisions on land management policy. All study site leaders were helped to

The screenshot displays the DESIRE Harmonised Information System website. At the top, the logo 'DESIRE' is prominent, followed by 'Harmonised Information System'. Navigation links include 'DESIRE Home', 'Contact', 'Site map', and '© DESIRE 2010'. A secondary navigation bar shows 'Desire project :: Home', 'Key messages', 'Research themes', 'Study sites', 'Publicity', and 'Archive'. The date '21 May, 2012' is shown in the top right.

The main content area is titled 'Key messages overview'. It includes a language selector set to 'English' and a search bar. The overview text states: 'This part of the Harmonised Information System contains all the key messages that have been concluded from the DESIRE research programme and study sites. The messages have been designed to be of interest at a number of spatial and organisational levels. Some of these messages have been circulated as news items, - as press releases, newsletters, podcasts and webcasts; and others are in booklets, factsheets, leaflets, policy briefs, or presentations.'

Key messages are listed with categories and brief descriptions:

- DESIRE video clip:** A video clip showing examples of the problems of desertification in various areas around the world and some of the local solutions that the DESIRE project has developed to alleviate them.
- Global level:** White papers, briefs and other documents containing research results from DESIRE on the causes, consequences and management of desertification and land degradation that are part of the European Union's commitment to support the United Nations Convention to Combat Desertification.
- National level:** Policy briefs demonstrating that research results from DESIRE are particularly relevant to the efforts, planning and policies of countries in which the study sites are located to combat, mitigate and ameliorate the effects of desertification and land degradation.
- Local stakeholder level:** Factsheets and storylines illustrating that throughout DESIRE, the collaboration between scientists and local people has yielded an exchange of information that includes evaluations of different approaches and techniques to prevent or control land degradation.
- Booklets and fact sheets:** A series of booklets (info-briefs) and shorter fact sheets demonstrating how DESIRE research is helping to mitigate different aspects of the problems of desertification and land degradation. Written in non-scientific language, the booklets are of interest to a wide range of stakeholder audiences, from policy makers to school children.
- Sharing the science:** The science behind the sustainable land management approaches and technologies recommended to dryland stakeholders around the world is shared with other researchers in scientific papers and at conferences. A major conference is that of the European Geosciences Union, held annually in Vienna. See some of the DESIRE posters and presentations presented in April 2012.
- Promoting gender equality:** Posters from each study site describing how new land use management gives additional time and other possibilities for women and men.

Additional features on the right side include a 'Translator login' section with fields for Username and Password, a 'Remember Me' checkbox, and a 'Login' button. Below this are links for 'Forgot your password?' and 'Forgot your username?'. An 'Acknowledgement' section features the DESIRE logo and text: 'The DESIRE project is co-funded by the European Commission, Global Change and Ecosystem. DESIRE brings together the expertise of 26 international research institutes and non-governmental organisations. This website does not necessarily represent the opinion of the European Commission. The European Commission is not responsible for any use that might be made of the information contained herein.' A 'Statistics' section shows 'Content View Hits : 758149'. A 'Follow us' section includes a Twitter icon. The footer notes 'Joomla! site by Envista'.

Fig. 6 The delivery of Key Messages on the DESIRE-HIS website (2012f)

make a policy brief in suitable language for policy makers. In the Chinese study site the brief focused on three ways to reduce soil erosion in the apple orchards of the loess plateau (DESIRE-HIS 2012k). The advantages of terracing, mulching and grass barriers were explained clearly and concisely in a practical way, but with sufficient information to replicate the technologies in similar areas.

Analysis of DESIRE-HIS Usage

Monitoring usage of the DESIRE-HIS has provided insight into whether or not the site is reaching its intended audience and providing information of interest to them. The hit counter has recorded (at time of writing) some 790,000 hits

since the site went online in 2007, but Google Analytics now provides far more specific information about site visitors and pages viewed.

In the 12-month period ending June 2012 the DESIRE-HIS recorded some 8,800 hits, 74 % of which were by new visitors. Sixty-four percent of the traffic came from search engines, of which Google provided the vast majority. Twenty percent of the traffic was referred from other sites, the DESIRE Project website accounting for two-thirds of these. Ninety-eight percent of access was from non-mobile devices, but most mobile access was by smartphones (numbers which are sure to increase). Finally, 15 % of traffic was from direct referrals (i.e. from a specific web link). The top four were to the Home page and to various

Info-briefs, all of which have been publicized by email, or Twitter, or in press releases through the UNCCD website or news lists such as LAND-L. Most viewers appear to be interested in general information about the project, the study sites and desertification, but not necessarily in the specific details.

The top ten countries from which visitors came were: USA, UK, Netherlands, Germany, Greece, Portugal, Italy, India, China and Spain; all except USA, Germany and India being DESIRE partner countries. The cities from which the website is accessed are also identified. For example there were a large number of visits from Eskisehir, Turkey, which is the location of a DESIRE study site. It is also possible to see how engaged visitors are with the site. 9.5 % of visitors looked at 2 pages and 2.5 % viewed 20+ pages. 1–3 min is sufficient to find and download a dissemination product to read offline. The conclusion from the monitoring was that DESIRE was reaching its intended audiences, both in the DESIRE study sites and in other countries. In addition, there have been numerous email requests for further information.

Discussion

Traditionally at the end of a research project, effort would be made to disseminate the results through a variety of academic publications plus, perhaps, an edited book, or themed journal special issues. For example, at the end of the MEDALUS II Project (1993–1995) an edited book was compiled and published by Wiley (Geeson and others 2002). The basic content of the book was not dissimilar from the most detailed level of content of DESIRE-HIS, with introductory and concluding chapters setting the context for the thematic and study site chapters. Retailing at £240, a few hundred copies have been sold, mostly to libraries. While the DESIRE-HIS cannot be a direct replacement for traditional scientific publications, it has the major advantage that it is not subject to such economic and access restrictions. It has been demonstrated that people read websites very differently from the way they read books, so that “visitors glance at each new page, scan some of the text and click on the first link that catches their interest” (Krug 2006). According to Nielson (2011) “the average page visit lasts a little less than a minute”. To make the most of website opportunities scientists experienced in writing closely reasoned arguments will need to learn new creative writing skills to deliver their core messages concisely.

Communication technologies have advanced at an increasing rate so that it is commonplace for researchers to search academic libraries for journals and books on the Internet instead of visiting library buildings. However, opportunities for communicating to other scientists and a

range of other users at a less technical level through websites have not yet reached their potential. On websites it has become very simple to include video clips with soundtracks in multiple languages, interactive tools, and links to networks such as Twitter. These are opportunities that should be exploited more fully in the future. For DESIRE-HIS a list of email subscribers was assembled. Email and Twitter were used to advertise new developments on the website and to ask for feedback. Newsletters and products such as Info- and Policy briefs have also been circulated in this manner, and positive feedback has been received.

The population of DESIRE-HIS has depended on timely input from project partners, not just in the form of formal research deliverables, but also in different versions for different types of user and in local languages. This enhanced dissemination has often needed more work than was originally envisaged. In future projects of this kind more time should be allowed for preparation of dissemination material. Another obstacle to providing the full sequence of research development online is that some research results and ideas cannot be released for public view until they have been formally published in academic journals. Since academic success in scientific institutions may depend on a record of journal publications, preparing academic papers takes priority if time is limited. Where it is not possible for all research authors to write products specifically for target stakeholder groups they should be encouraged to convert parts of their academic publications to less scientific language and post them on a project website or submit them to a range of online magazines, newsletters or blogs. In the case of desertification these could be the UNCCD’s weekly LAND SCAN (2013), or DNI Newsletter (2013).

Analysis of usage of DESIRE-HIS has proved that information about the DESIRE Project has been accessed by thousands of people around the world. This is a huge increase on the numbers who read academic books or articles in journals in a traditional way. We suggest that the DESIRE-HIS has exceeded its original aims merely to extend research results to a wider audience, and now provides a model for succeeding research projects to follow (LEDDRA Project 2013; CASCADE Project 2013).

A key feature of the DESIRE Project (2012) was the evaluation of the trialed sustainable land management technologies to counter the risk of land degradation on a regional scale. Analysis of costs and benefits is complex, dependent on many factors and variable over time. Models, particularly PESERA and DESMICE (DESIRE-HIS 2012i) provide scenarios and options to suit a wide range of potential users. Full details of recommended remediation strategies for policymakers and agricultural advisors/extensionists within each region are provided on DESIRE-HIS (2012m).

Conclusion

There have been a large number of recent projects where scientists have involved a wide range of stakeholders in their research to promote sustainable land management technologies. However, at the end of such projects it has often been difficult to sustain interest by stakeholders and continue to provide easy access to key information. We are currently experiencing rapid developments in communication technology, and large numbers of people around the world regularly access websites and social media such as Twitter. Research projects may capitalize on these opportunities that provide enduring and cost-effective dissemination mechanisms. DESIRE-HIS, the online Information System of the DESIRE Project has made 5 years' worth of complex research easily accessible to a wide range of stakeholders including researchers, land users and policy makers.

The DESIRE-HIS is organized so that the logical progression of the work of the project is clear, for the research themes and also for each of the 17 study sites. The interaction of various forms of knowledge through DESIRE-HIS, such as scientific, expert, local and lay knowledge, generates "knowledge building". Knowledge is generated and applied through interaction between actors and disseminated, re-contextualized and socially re-embedded so that it can be used in other contexts or learned by different actors. Logical organization and good sign-posting on a website are essential for providing a very easy and quick way of sharing research information.

With the DESIRE-HIS, the DESIRE Project has introduced an innovative way of communicating research results to a wide-ranging audience, including online videos and podcasts. Key information from scientific research is traditionally targeted at academic journals, but this cannot provide sufficient access for all those who need this information. In particular, it is the land users and land owners who can learn to plan for more sustainable land management, and policy makers who need concise summaries providing a basis for making decisions on cost-effective actions relating to land degradation and associated issues. For example, as evidence for global climate change increases, often with unpredictable effects on local weather and soil status, food production in some locations may be impeded, and already food security issues reach international news headlines (International Food Policy Research Institute 2011). The UNCCD has called for improved awareness-raising and dissemination of best practices around the world, and the DESIRE-HIS has responded to this challenge in a comprehensive and pioneering way.

During the period of the DESIRE Project many lessons have been learned from developing the DESIRE-HIS, particularly about which methods of communication work

best in different circumstances. The main conclusion is that a wide range of stakeholders should be identified and involved at the beginning of all such projects, and communication with them should be maintained by whatever methods are most welcomed. Analysis of website usage shows us which information is accessed most frequently, and guides us to enlarge on popular formats and make improvements in response. Scientists engaged in research projects should be encouraged to compose their results not only for academic journals, but also in less scientific language for selected newsletters, magazines and other fora, both in printed hard copy and on the Internet. The DESIRE Project has demonstrated the publicity benefits of an online Information System, and other projects are beginning to follow this lead. As communication technologies continue to develop very rapidly the options for communication to a wider audience in various formats are expanding. However, the needs of those whose communication is primarily verbal and who have no access to communication technology should always be considered to ensure their inclusion and participation.

Acknowledgments The authors have been funded by: EU DG RTD 6th Framework Research Programme (sub-priority 1.1.6.3) Research on Desertification: Desertification Mitigation and Remediation of Land—a Global Approach for Local Solutions (DESIRE) Project (Contract Number: 037046). We would like to thank colleagues (especially Rudi Hessel), and the reviewers, who have all helped to improve this paper.

Conflict of interest The authors declare that they have no conflict of interests.

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