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Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia (RAISE) Database

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Abstract

The extensive data sets obtained during the Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia (RAISE) project from 2001 through 2007 have been organized as a database both on the web and as DVD-ROMs. The web version will continue to be updated whenever corrections/additions etc. become necessary, while the DVD-ROMs version is a frozen copy of the web version as of March 4, 2008.

Key words: database, Mongolia, northeastern Asia, hydrology, meteorology and climatology, geomorphology, plant ecology, and soil science.

1. Introduction

Rangelands occupy some 30-50% of the earth's land area (World Resources Institute, 2000; Houghton *et al*., 2001), and they supply more than 80% of the feed of the livestock in Asia and Africa, about 25% in north and central America and some 50% in the rest of the world (Allen-Diaz *et al*., 1996). Thus rangelands are of vital importance for the production of live stock. Also for the global climate, rangelands have a strong impact. For example, they store 405-806 Gt of carbon (World Resources Institute, 2000) and absorb about 0.5 PgC per year (Scurlockand Hall, 1998). Given their large extent and importance, it is crucial to have a thorough understanding of the natural environments of the rangelands, in general, and of the mechanisms that maintain or change the ecosystem in response to the environmental changes in particular.

In northeastern Asia around Mongolia, a climatic transition from humid conditions in the northern part to arid conditions in the southern part can be found over a relatively narrow, boundary zone (see, e.g., Fig. 1.1 of Simmers, 2003). As a consequence of the steep, meridional gradient in climate, a distinct ecotone of forest-steppe-desert is formed in this part of the world (Fig. 1). An ecotone in general is sensitive and susceptible to environmental changes (e.g., Pogue and Schnell, 2001) such as global warming even when the extent of the change is small. In reality, it has been reported that winter and spring air temperatures have increased in this region (Yatagai and Yasunari, 1994) while the summer total precipitation appears to have increased, with also increased frequency of heavier rainfall in eastern and western Mongolia over the last four decades (Endo *et al*., 2006). It is possible that such climatic changes may have induced or will induce drastic changes in plant growth and vegetation distribution directly or indirectly through changes in hydrological cycle. Another driving force of ecosystem changes results from human activities. In Mongolia, the number of livestock has increased drastically in the past decade or so (Fig. 2), as a result of the introduction of the so-called market oriented economy in 1990-91 after the change of the political system; the effect of the resulting overgrazing onto the ecosystem could be a serious problem. Currently, most of Mongolia is classified as being in a state of slight desertification (e.g., Dregne, 1986). However, until now no comprehensive scientific studies have dealt with desertification in this region.

These are the background to have organized and carried out an interdisciplinary study of rangelands in northeastern Asia called RAISE (the Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia, Sugita *et al*., 2007) with participation of more than 30 scientists with backgrounds in hydrology, meteorology, climatology, geomorphology, soil science, and plant ecology from Japan, Mongolia, China and Korea. Its main intensive field observations took place in 2003 in and around Kherlen river basin (Figs.1 and 3) with supplementary observations in 2004-2007. In addition to such special observations, the routine data of meteorology, hydrology and agrometeorology being measured by the Institute of Meteorology and Hydrology (IMH) of Mongolia have been collected. Similarly relevant maps, atlases, statistical data were listed and archived. Since

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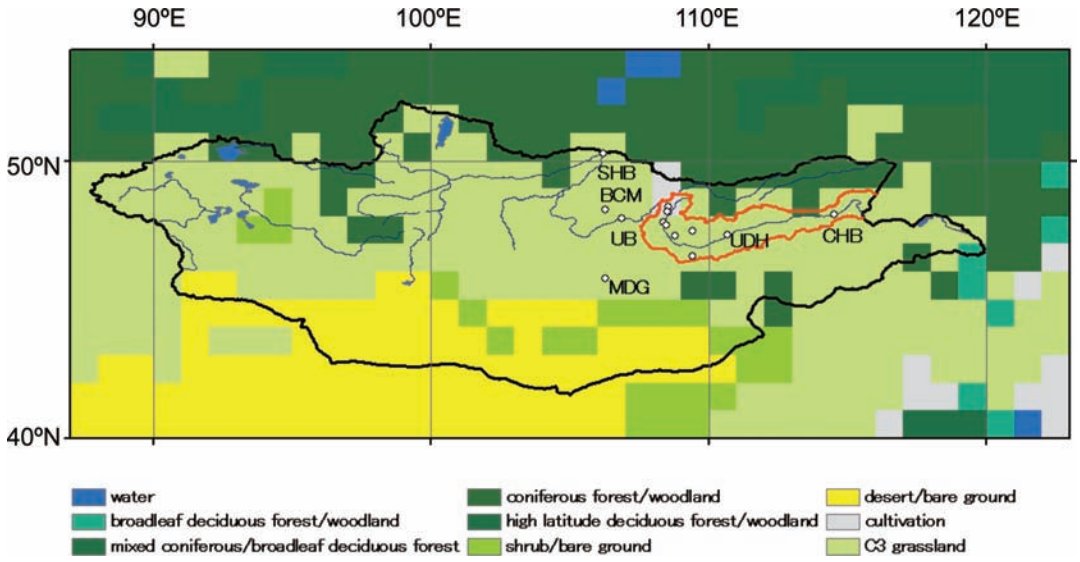

Fig. 1 A map showing the vegetation coverage in northeastern Asia with the location of the Khelren river basin and major rivers and lakes. Vegetation classification by DeFries and Townshend (1994) is used. Open circles represent RAISE observation points. Location names are as follows. SHB: Sukhbaatar, MDG: Mandalgobi, UDH: Underhaan, and CHB: Choibalsan, and UB: Ulaanbaatar. The names of the points within Kherlen river basin, whose boundary is shown by white lines, are shown in Fig. 3. For the detailed vegetation within the Kherlen river basin, see Fig. 3.

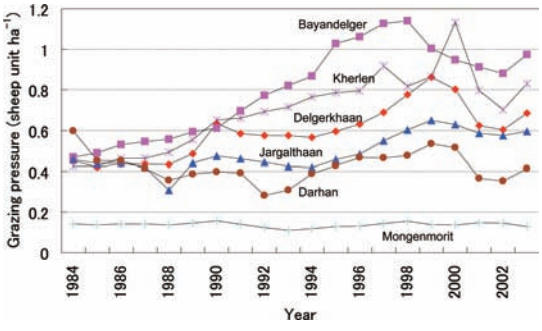

Fig. 2 Changes in annual mean grazing pressure in sheep unit/ha at selected soums (Mongolian administrative unit equivalent of county) from 1984 to 2003. Circles represent grazing pressure in Darhan (DH) soum (with an area of 4.4×10^5 ha), squares in Bayandelger soum (2.3×10^5 ha) that included Baganuur (BGN), triangles in Jargalthaan (JGH) soum (3.0×10^5 ha), asterisks in Kherlen soum (2.5×10^5 ha) that includes Underhaan (UDH), crosses in Mongenmorit soum (6.7×10^5 ha) (MNG), and diamonds in Delgerkhaan soum (3.0×10^5 ha) that includes Kherlenbayan-Ulaan (KBU). See Fig. 3 for the exact locations of these soums.

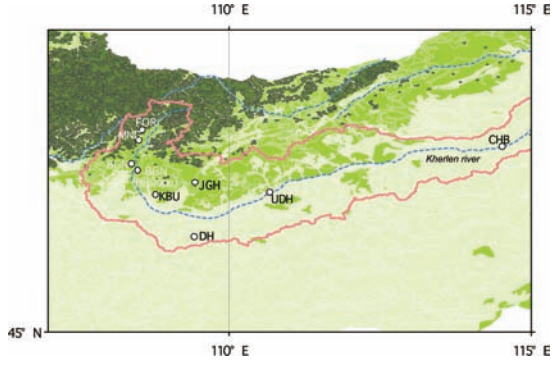

Fig. 3 Distribution of vegetation in the Khelren river basin on the basis of data provided by Saandar and Sugita (2005). The black color indicates forest, the gray colors the mountain steppe, and the bright gray the steppe region. Note that vegetation data are not available outside the Mongolian border toward the north of the Kherlen river watershed, and their area is left blank. Circles denote the location of the IMH and RAISE stations. BGN: Baganuur, BGN (hillslope): hillslope observation site in Baganuur, KBU: Kherlenbayan-Ulaan, DH: Darhan, UND: Underhaan, JGH: Jargalthaan, FOR: forest stie near MNG, MNG: Mongenmorit, and CHB: Choibalsan. White thick lines represent the basin boundary while the dotted lines indicate major rivers.

these data are invaluable for future researches and other purposes, it was decided to organize them as a database and be provided for general scientific communities wherever possible. This has been carried out by creating two versions of the database. One is DVD-ROMs version (Sugita *et al.*, 2008) for use on a personal computer. Another version is intended to be accessed through the Internet. The former is more user-friendly, particularly for those in an area with limited network access. The latter is more convenient if a user knows which particular data files he or she intends to use. The data and related files are likely to be more up-to-date, since the DVD-ROMs version is a frozen copy of the database as of March, 2008 while the web version will be updated whenever new

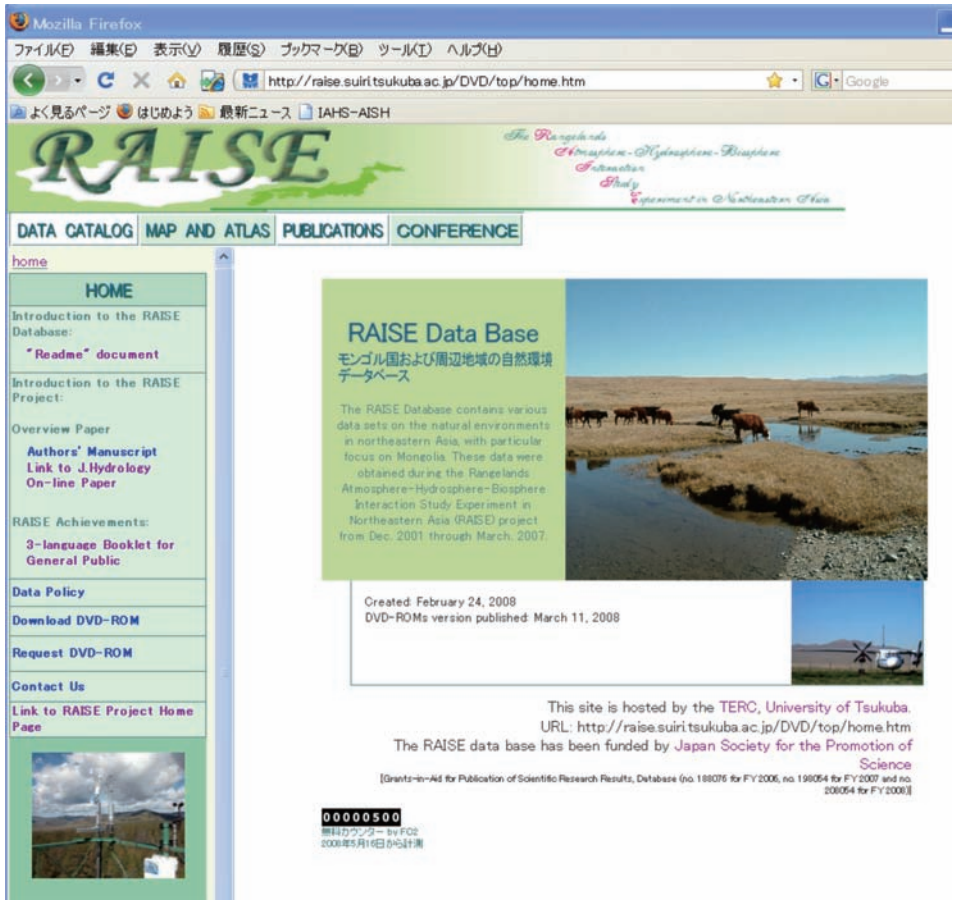

Fig. 4 The RAISE database home page
at http://raise.suiri.tsukuba.ac.jp/DVD/top/home.htm.

information becomes available and whenever corrections become necessary. Since some of the data are copy-right articles, restriction to the access to these limited data was inevitable. Nevertheless, listing of these data are still useful in that the presence of such data can be known and it is possible to obtain them directly from the copy-right holders when a need arises.

2. Organization of the database

The items included in the database are classified in the following manner:

- Data
- Maps and Atlases
- Publications
- Conference

They are organized and accessible through a web browser. As can be seen in Fig.4, these sections are shown on the top menu.

The data section is the main part of the database and includes actual data as well as supplementary documents and figures as explained below. The maps and atlases section list those collected during the RAISE project. Most of the items included in this section are copy-right articles and thus are not included or not open to the general users of this RAISE database. Rather, these listings are intended to provide information that such atlases or maps are available and could be obtained or purchased from each copy right holder in a formal manner. The publications section are for archives of the RAISE related articles. These consist of (i) original, peer-reviewed articles published in scientific journals, (ii) books, (iii) conference proceedings papers and (iv) theses and dissertation. The conference and meetings section provide information on the five major meetings of the RAISE project.

The organization of the data section is straightforward; they can be accessed through web-browser by choosing "Data catalog" of the homepage top menu (Fig.4) of the DVD-ROMs and Web versions. Once on the Data catalog section (Fig. 5), it is immediately obvious that data are organized and cataloged as shown by the side menu on the left (Fig.5) and also in the following manner:

- DVD ROM #1
  - Hydrometeorological Components
  - Aircraft Observation

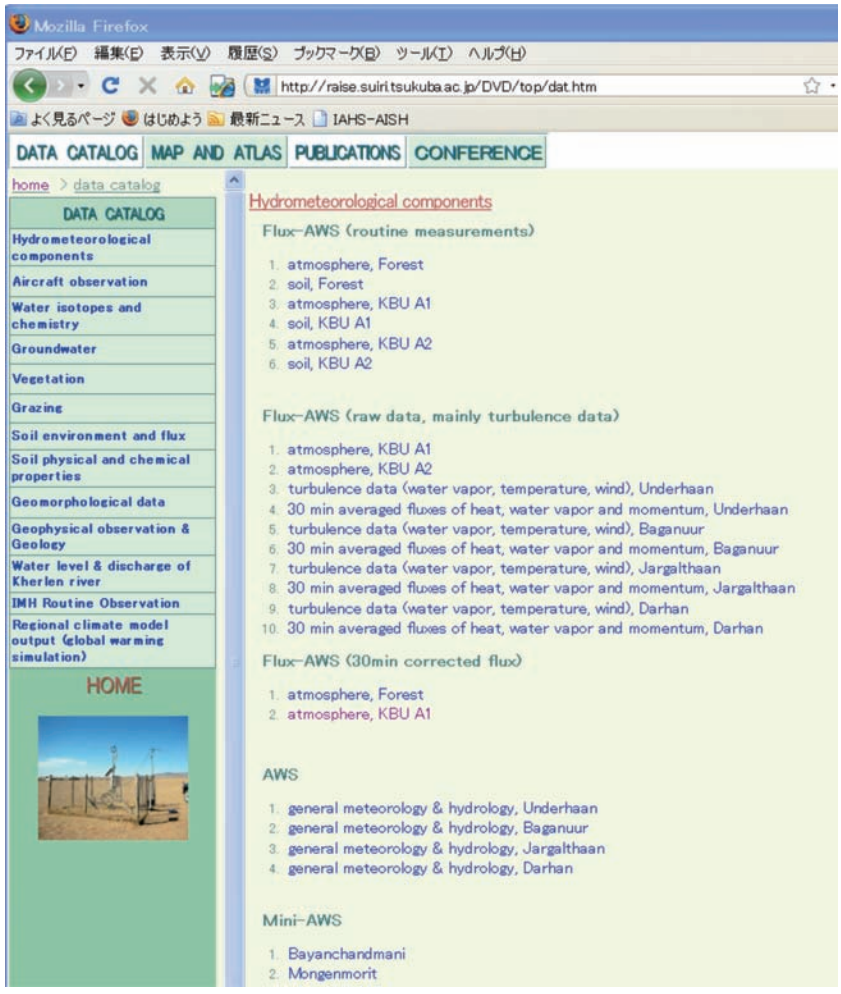

Fig. 5 The RAISE database data catalog page for access to the datasets and relevant documentations and figures.

- DVD ROM #2
  - Water Isotopes and Chemistry
  - Groundwater
  - Vegetation
  - Grazing
  - Soil Environment and Flux
  - Soil Physical and Chemical Properties
  - Geomorphological Data
  - Geophysical Observation & Geology
  - Water Level & Discharge of Khelren River
  - IMH Routine Observation
- DVD ROMs #3 - #5
  - Regional Climate Model Outputs

DVD ROMs numbers are relevant only for the DVD version. On the Web version, there is no indication of the DVD-ROM numbers. In each category are the subcategories in which individual data sets are available. Each data set entry is made up with the following items (see Fig.6 as an example):

- Data set
- Data set documentation
- Station documentation
- Topographic Map
- Vegetation Map
- Satellite Image

Again, each item can be accessed by choosing the relevant top menu.

3. Miscellaneous information

3.1 Usage restriction

All data sets are in general open to the general scientific communities. Use of the data for non-commercial purposes (such as for research and education) is granted free of charge. However, there is a certain restriction (such as a request for acknowledgement in a published article) specific to each data set, and users should check with the description in the “data set documentation” for

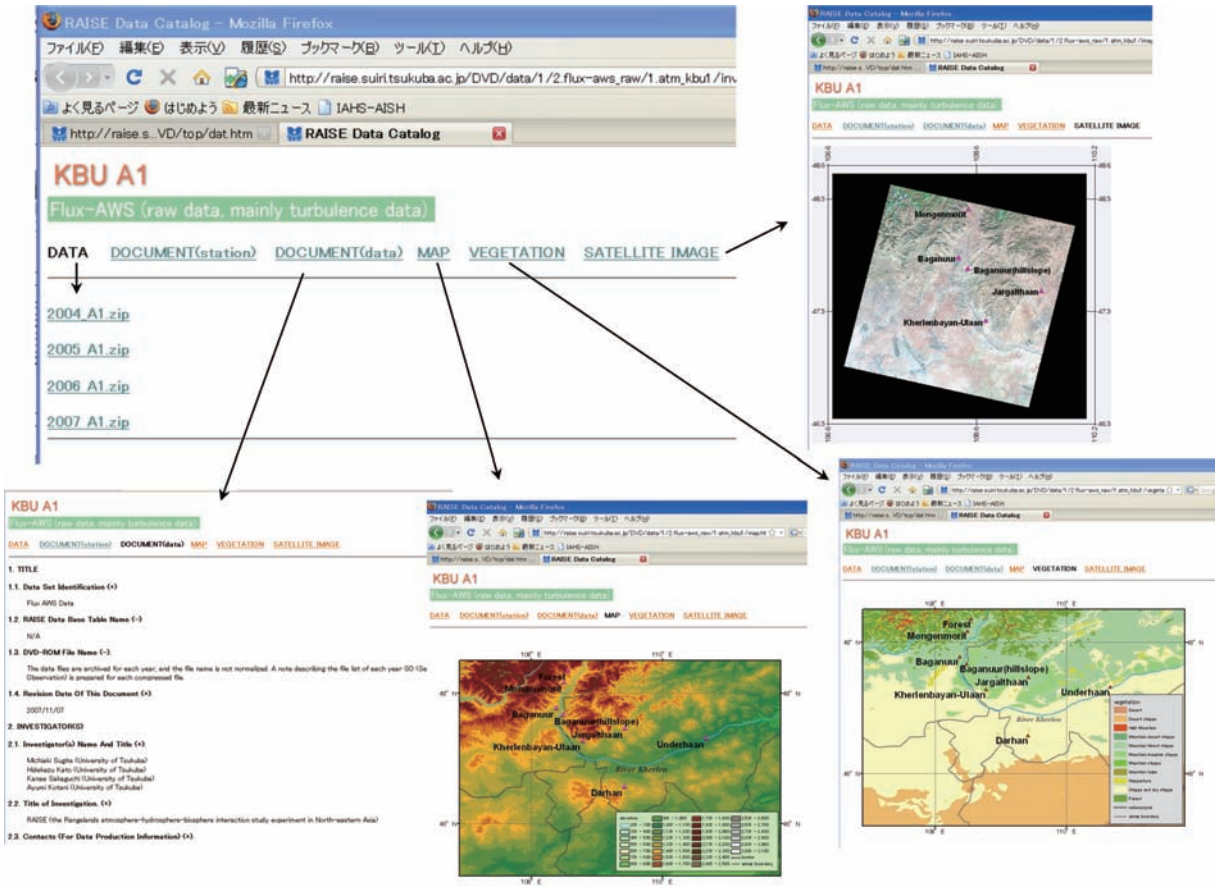

Fig. 6 An example of data presentation. This is an example of the flux observation data set. As can be seen and accessed from the top menu, there are in general 6 subcategories of "Data", "Document (station)", "Document (data)", "Map", "Vegetation" and "Satellite Image" which are shown as inserts to the figure with arrow lines extended from the top menu.

details. Also, as explained above, there are some data sets that cannot be open, except for the RAISE scientists due mainly due to the request of the copyright holders such as the Mongolian government. The details can be found in the data set documentation of each data set. Those who might want to access to these restricted items should reach relevant organization/persons to obtain permission of the usage.

3.2 Request for the DVD-ROMs and citation of the database set

The DVD-ROMs version can be ordered (as long as the stock is available), free of charge, by sending the following information to the address given below.

Needed information: name, organization, postal address, phone and e-mail address
Address: RAISE database, Terrestrial Environment Research Center, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan
e-mail: raise@suiri.tsukuba.ac.jp

When data in this DVD-ROMs database are used in scientific researches, please add the following reference to the publication.

Web version:
Sugita, M., Asanuma, J., Tsujimura, M., Mariko, S., Lu, M., Kimura, F., Azzaya, D., and Adyasuren, T., Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia (RAISE) Database, Terrestrial Environment Research Center, University of Tsukuba, Tsukuba, Ibaraki, Japan, http://raise.suiri.tsukuba.ac.jp/DVD/top/home.htm

DVDs version:
Sugita, M., Asanuma, J., Tsujimura, M., Mariko, S., Lu, M., Kimura, F.,Azzaya, D., and Adyasuren, T., (2008): Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia (RAISE) Database, DVD-ROMs, Terrestrial Environment Research Center, University of Tsukuba, Tsukuba, Ibaraki,

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References

Allen-Diaz, B., Chapin, F. S., Diaz, S., Howden, M., Puidefabregas, J., Stafford, M., Benning, T., Bryant, F., Campbell, B., duToit, J., Galvin, K., Holland, E., Joyce, L., Knapp, A. K., Matson, P., Miller, R., Ojima, D., Polley, W., Seastedt, T., Suarez, A., Svejcar, T., Wessman, C., Ekaya, W. N., Ellis, J., Incoll, L. D.,Kinyamario, J., Magadza, C., Oikawa, T., Sala, O., Scoppa, C., Maceira, N., Rodriguez, R., 1996. Grassland and Rangelands. In Watson, R.T., Zinyowera, M.C., and Moss, R.H. (Eds.), *Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge Univ. Press, Cambridge, UK and New York, NY, USA, 878p.

DeFries, R.S., and Townshend, J., 1994. NDVI-derived land cover classification at global scales. *Intern. J. Remote Sens.*, **15**, 3567-3586.

Dregne, H.E., 1986. Desertification of arid lands. In: El-Baz F. and Hassan, M.H.A. (Eds), *Physics of Desertification*. Mrtinus Nijhoff Publishers, Dordrecht, the Netherlands. 4-34.

Endo, N., Kadota, T., Matsumoto, J., Ailikun, B., Yasunari, T., 2006. Climatology and trends in summer precipitation characteristics in Mongolia for the period 1960-98. *J. Meteorol. Soc. Jpn.*, **84**, 543-551.

Houghton, J. T. Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K., Johnson, C.A., 2001. *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge Univ. Press, Cambridge, UK and New York, NY, USA, 881p.

Pogue, D.W., and Schnell, G.D., 2001. Effects of agriculture on habitat complexity in a prairie-forest ecotone in the Southern Great Plains of North America. *Agricul. Ecosystems & Environ.*, **87**, 287-298.

Saandar, M., and Sugita, M., 2004. *Digital Atlas of Mongolian Natural Environments, (1) Vegetation, Soil, Ecosystem and Water*, CD-ROM, Monmap Engineering Service Co., Ltd, Ulaanbaatar 210646, Mongolia.

Scurlock J.M.O., and Hall D.O. 1998. The global carbon sink: a grassland perspective. *Global Change Biol.*, **4**, 229-233.

Simmers, I., 2003. *Understanding Water in a Dry Environment*. A.A. Balkema Publ., Lisse, the Netherland.

Sugita, M., Asanuma, J., Tsujimura, M., Mariko, S., Lu, M., Kimura, F., Azzaya, D., and Adyasuren, T., 2007. An overview of the rangelands atmosphere-hydrosphere-biosphere interaction study experiment in northeastern Asia (RAISE). *J. Hydrol.*, **333**, 3-20.

Sugita, M., Asanuma, J., Tsujimura, M., Mariko, S., Lu, M., Kimura, F., Azzaya, D., and Adyasuren, T., 2008. *Rangelands Atmosphere-Hydrosphere-Biosphere*

Interaction Study Experiment in Northeastern Asia (RAISE) Database, DVD-ROMs, Terrestrial Environ. Res. Ctr., Univ. Tsukuba, Tsukuba, Ibaraki, Japan,

World Resources Institute, 2000. *World Resources 2000-2001. People and Ecosystems: The Fraying Web of Life*. World Resour. Inst., Washington, DC, USA, 400 p.

Yatagai A., Yasunari, T. 1994. Trends and decadal-scale fluctuations of surface air temperature and precipitation over China and Mongolia during the recent 40 year period (1951-1990). *J. Meteorol. Soc. Jpn.*, **72**, 937-957.

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