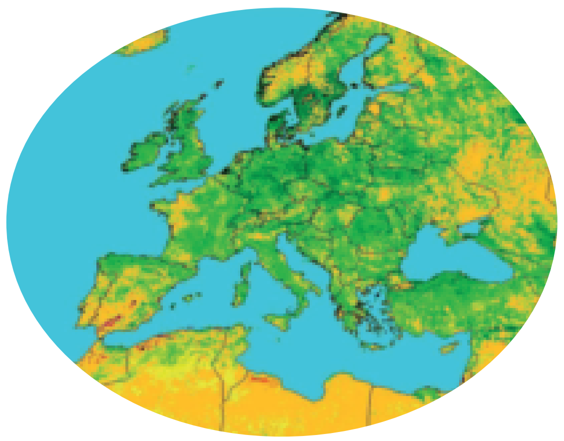
EMERGING DISEASES IN A CHANGING EUROPEAN ENVIRONMENT

EDEN is an Integrated Project of the 6th FP (2004-2009) funded by the European Commission under the Research DG, Environment Directorate, priority 6.3: Global Change and Ecosystems

Contract Number: GOCE-CT-2003-010284 EDEN

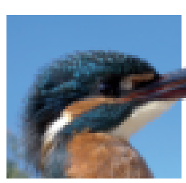
EDEN is based on a network of 80 teams involving 49 scientific partners from 24 countries of Europe and the Mediterranean basin; Senegal is the link with sub-Saharan ecosystems.

Between October 2004 and May 2008, more than 100 articles by project members were published or are in the pipeline. A list can be consulted on the project website. Numerous theses have been or are to be defended. The PhD network, set up on the initiative of the project, is very active and ensures long-term collaboration. Lastly, a website has been developed to facilitate exchanges of information, provide documentation and scientific software, and to seek employment.



Increase of mean NDVI values across Europe, 1982-1999

Contact Eden Secretariat
CIRAD
TA A-Dir / B
34398 Montpellier Cedex 5
France
eden@cirad.fr
Tel.: +33 (0)4 67 59 37 37
General information: www.eden-fp6project.net
Data management: http://ergodd.zoo.ox.ac.uk/eden/
PhD network: http://ergodd.zoo.ox.ac.uk/edenphd/



Photographs
G. Balança/CIRAD; J.B. Ferré/EID-Méditerranée;
G. Hendrickx/AVIA-GIS; H. Henttonen/METLA;
R. Lancelot/CIRAD; E. Oksannen/METLA.

Partners

- Avia-GIS – *Belgium*
- "Béla Johan" National Centre for Epidemiology – *Hungary*
- Centre de coopération internationale en recherche agronomique pour le développement – *France*
- Centre for Communicable Disease Prevention and Control – *Lithuania*
- Consejo Superior de Investigaciones Científicas – *Spain*
- Danube Delta National Institute for Research and Development – *Romania*
- Ege University Medical School – *Turkey*
- Entente interdépartementale pour la démoustication du littoral – *France*
- Euro-Aegis – *United Kingdom*
- Faculty of Medicine-Medical University of Bialystok – *Poland*
- Finnish Forest Research Institute – *Finland*
- Fondazione Edmund Mach – *Italy*
- Hacettepe University – *Turkey*
- Institut agronomique et vétérinaire Hassan II – *Morocco*
- Institut de recherche pour le développement – *France*
- Institut national de la recherche agronomique – *France*
- Institut national d'hygiène – *Morocco*
- Institut Pasteur – *France*
- Institut Pasteur d'Algérie – *Algeria*
- Institut Pasteur de Dakar – *Senegal*
- Institut sénégalais de recherches agricoles – *Senegal*
- Institute of Vertebrate Biology. Academy of Sciences of the Czech Republic – *Czech Republic*
- Institute of Zoology. Slovak Academy of Sciences – *Slovakia*
- Instituto de Higiene e Medicina Tropical. Universidade Nova de Lisboa – *Portugal*
- Instituto de Salud Carlos III – *Spain*
- Istituto Superiore di Sanità – *Italy*
- Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale" – *Italy*
- London School of Hygiene & Tropical Medicine – *United Kingdom*
- Ludwig-Maximilians-Universität München – *Germany*
- National Institute for Health Development – *Estonia*
- National Institute of Research and Development for Microbiology and Immunology "Cantacuzino" – *Romania*
- Natural History Museum – *United Kingdom*
- Neiker – *Spain*
- Public Health Agency – *Latvia*
- Swedish Institute for Infectious Disease Control – *Sweden*
- Szent Istvan University. Faculty of Veterinary Science – *Hungary*
- Università degli Studi di Roma La Sapienza – *Italy*
- Universitat de Barcelona – *Spain*
- Universitat de Valencia – *Spain*
- Université catholique de Louvain – *Belgium*
- Université Montpellier I – *France*
- Universiteit Antwerpen – *Belgium*
- University of Crete – *Greece*
- University of Helsinki – *Finland*
- University of Liverpool – *United Kingdom*
- University of Ljubljana. Faculty of Medicine. Institute of Microbiology and Immunology – *Slovenia*
- University of Oxford – *United Kingdom*
- University of Utrecht – *Netherlands*
- Veterinary Medical Research Institute. Hungarian Academy of Science – *Hungary*

NovaTerra • Montpellier • 07/2008

EMERGING DISEASES IN A CHANGING EUROPEAN ENVIRONMENT

E D E N

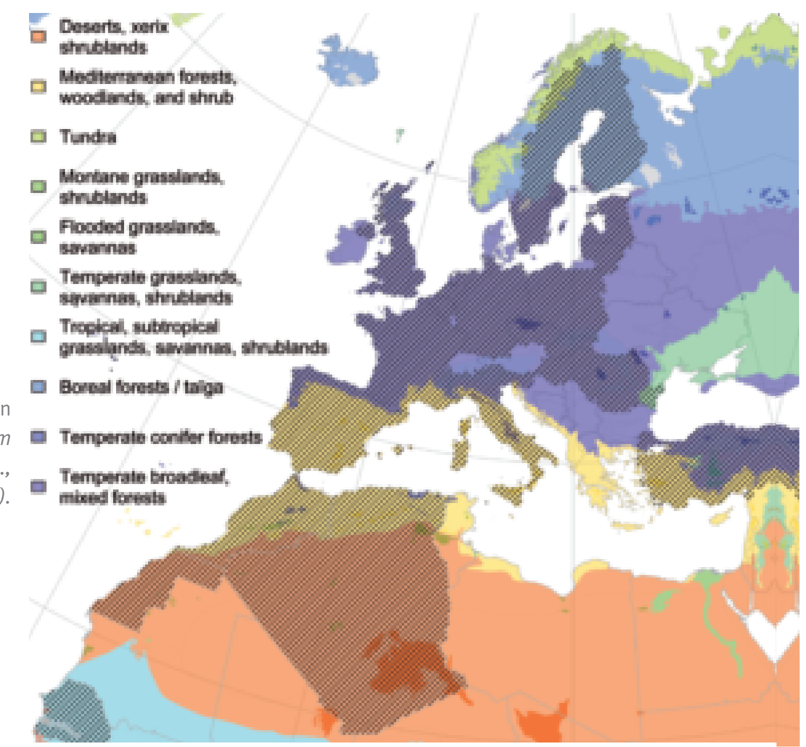
An integrated project to predict the risk of vector-borne diseases

Epidemics of emerging, vector-borne diseases increasingly threaten humans: Rift Valley fever, leishmaniasis, or tick-borne encephalitis are recent contrasting examples. Moreover, wild or domestic animals such as rodents, dogs or ruminants can harbour pathogens and contribute to maintain human infections. Changes in natural conditions can lead to transmission to humans on epidemic scales. Human behaviour, influenced by the social and economic environment, and activities such as trade or travel, may increase contact with vectors and animal hosts, and cause the spread of vectors and diseases.

To understand vector, pathogen and animal host dynamics, explain the intensity of disease transmission to humans in relation to global environmental changes, and define appropriate monitoring, prevention and control measures, the European Commission launched the EDEN project, coordinated by CIRAD and involving 24 countries from Europe, the Middle East and Africa.

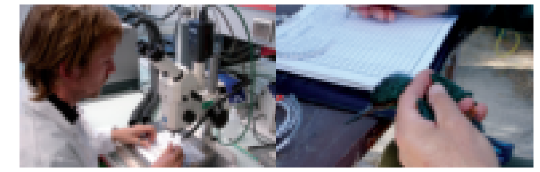
Since its creation, EDEN has contributed significantly to understanding and modelling the conditions for vectorial diseases to occur and spread, depending on the regions and time of year. The second phase of the project will build on this foundation, combining the results to gain an overall picture of emergence risks and provide methods and tools to design surveillance networks and early warning systems.

Countries involved in EDEN (shaded)



Biome distribution (*adapted from D. M. Olson* et al., *2001*).

Scientific network for integrated results



Characterizing epidemiological situations

Model diseases have been selected to represent the range of risks and epidemiological situations.

• Tick- and rodent-borne diseases are endemic in Europe. Their incidence varies depending on the regions, and the risk of their spreading is not well known.

• Leishmaniasis is transmitted by biting sand flies, with an animal host (dogs). It exists around the Mediterranean basin, and is spreading North due to poorly understood changing environmental factors that may include global warming.

• West Nile fever and Rift Valley fever are transmitted by mosquitoes. They are endemic in sub-Saharan Africa, but sometimes spread to the Mediterranean basin, the Middle East and Europe.

• Malaria was endemic in Europe, including in its northern regions (Scandinavia, Russia). Although it has been eradicated in Europe, its vectors are still abundant. Might environmental changes and international travel allow its reappearance?

Two examples show how studying epidemiological processes leads to the construction of risk models.

• Given the high quality public health data available in the Baltic States, it has been possible to carry out precise studies on risk factors for the incidence of tick-borne encephalitis. Climate change alone cannot explain the heterogeneity of the situations encountered. Other factors are involved, such as industrial and agricultural changes, and the behaviour of human populations. This precise knowledge of the epidemiological processes suggests it will be possible to achieve a generic model for tick-borne encephalitis in Europe.

• In the Camargue, malaria has been eradicated but its vectors are still there. Social, economic and agricultural policies (Marshall Plan, common agricultural policy) are largely behind the expansion of paddy fields, veritable mosquito factories. The abundance of these vectors is, itself, largely determined by the use of pesticides to control rice diseases, and the dissemination of varieties resistant to those diseases. Moreover, human behaviour is central to explaining exposure to mosquito bites and malaria risk, if the parasite were to be re-introduced into the environment. ❖

For the 49 partners and 80 teams involved in the project, it is not merely a matter of working together on top quality research in different fields, but also taking an integrative approach to reveal the overall situation.

The main aims are to:

• Characterize the ecosystems most exposed to local changes and to risks of introducing and spreading vector-borne emerging diseases.

• Cover a wide enough range of diseases to gain an overall picture of emergence risks in European ecosystems.

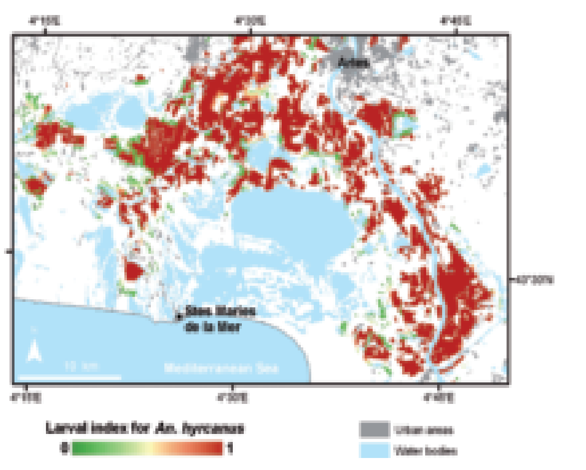
• Lay the foundations of a surveillance and early warning policy for vector-borne diseases in Europe.

EDEN is organized in six sub-projects: tick- and rodent-borne diseases, leishmaniasis, West Nile fever, malaria, and the African platform (West Nile fever and Rift Valley fever).

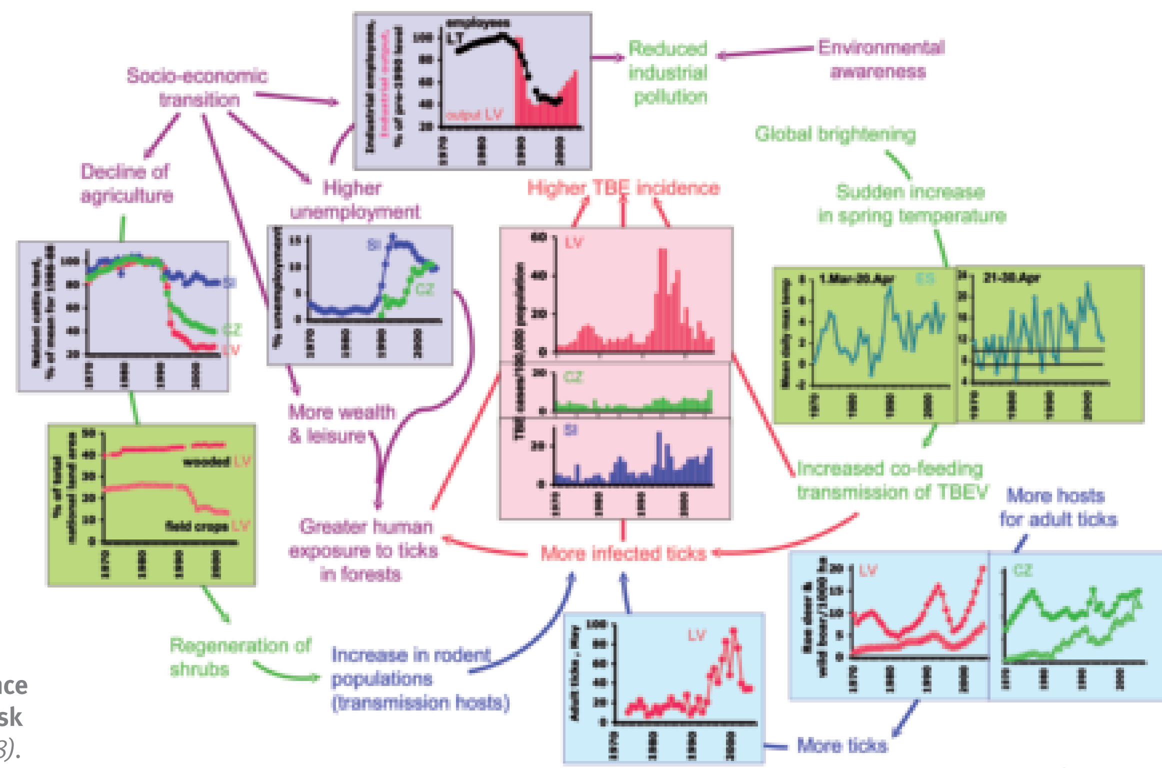
To strengthen the integrative approach, each sub-project works with the same set of additional teams specialised in information and data management systems, low and high resolution remote sensing, and change indicators (including biodiversity), or in statistical and mathematical modelling of vector population dynamics and disease transmission.

A secure web site has been developed to facilitate data management and data sharing between the partners, and provide specific information and links for external users.

The same work plan has been adopted for each sub-project in order to compare epidemiological situations. A steering committee meets three times a year to assess the progress made in activities. The emerging strategy document presents the concepts and the approach, provides dissemination models based on global change scenarios, and makes recommendations for effective surveillance and early warning for each disease. ❖



High-resolution mapping of larval habitat and abundance of *Anopheles hyrcanus* in the Camargue to study the risk of malaria resurgence *(adapted from A. Tran et al., 2008).*



Conceptual transmission model of tick-borne encephalitis in northern Europe *(adapted from D. Sumilo et al., 2007).*

Providing tools to predict epidemiological risks

Methods have been developed to simplify integration of the different teams' data.

• A new temporal Fourier analysis method is used to process medium-resolution satellite images and thereby monitor variations in environmental indicators with spatial and temporal resolutions enabling wide regions to be covered. It is thus possible to characterize changes on the scale of a country or a continent: trend, seasonal distribution, etc. When epidemiological cycles are known, climatic and environmental parameters determining their dynamics can be translated into indicators observed by remote sensing. In the opposite case, statistical methods have been developed for selecting variables to generate plausible and parsimonious models.

• In order to assess the risk of a disease becoming established in a new ecosystem, the basic reproduction number, R_0, is an essential indicator: it quantifies the number of secondary cases caused by the introduction of an infectious individual in a disease-free population, and consequently the risk of an epidemic. Its expression is difficult for complex diseases, such as those transmitted by ticks. New models have been developed to overcome such difficulties. They confirm the importance of simultaneous feeding of ticks on the same host for tick-borne encephalitis virus to become established in a new ecosystem.

• Computer models, such as multi-agent systems, can be used to integrate human behaviour, as well as host and vector dynamics depending on environmental changes. ❖

For more information

Deter J., Chaval Y., Galan M., Gauffre B., Morand S., Henttonen H., Laakkonen J., Voutilainen L., Charbonnel N., Cosson J. 2008. Kinship, dispersal and *Hantavirus* transmission in bank and common voles. *Archives in Virology*, **153**: 435-444.

Faraj C., Adlaoui E., Ouahabi S., Lakraa E., Elkohli M., Aouad R.E. 2008. Extension vers le nord du Maroc de l'aire de distribution de *Anopheles (Cellia) d'thali* Patton, 1905. *Bulletin de la Société de Pathologie Exotique*, **101**: 62-64.

Figuerola J., Soriguer R., Rojo G., Tejedor C.G., Jimenez-Clavero M.A. 2007. Seroconversion in wild birds and local circulation of West Nile virus, Spain. *Emerging Infectious Diseases*, **13**: 1915-1917.

Hartemink N.A., Randolph S.E., Davis S.A., Heesterbeek J.A.P. 2008. The basic reproduction number for complex disease systems: defining R_0 for tick-borne infections. *The American Naturalist*, **171**: 743-754.

Hubálek Z., Halouzka J., Juricová Z., Sikutová S., Rudolf I. 2006. Effect of forest clearing on the abundance of *Ixodes ricinus* ticks and the prevalence of *Borrelia burgdorferi* s.l. *Medical and Veterinary Entomology*, **20**: 166-172.

Linard C., Tersago K., Leirs H., Lambin E.F. 2007. Environmental conditions and Puumala virus transmission in Belgium. *International Journal of Health Geographics*, **6**: 55.

Martinez S., Vanwambeke S., Ready P. 2007. Linking changes in landscape composition and configuration with sandfly occurrence in southwest France. *International Workshop on the Analysis of Multi-temporal Remote Sensing Images, MultiTemp 2007*: 1-5.

Olson D.M., Dinerstein E., Wikramanayake E.D., Burgess N.D., Powell G.V.N., Underwood E.C., D'amico J.A., Itoua I., Strand H.E., Morrison J.C., Loucks C.J., Allnutt T.F., Ricketts T.H., Kura Y., Lamoreux J.F., Wettengel W.W., Hedao P., Kassem K.R. 2001. Terrestrial ecoregions of the world: a new map of life on earth. *BioScience,* **51**: 933-938.

Olsson G.E., Hörnfeldt B., Hjertqvist M., Lundkvist A. 2007. Sorkfeberprognos: stor smittrisk i Norrland i vinter. *Läkartidningen*, **104**: 1-4.

Ponçon N., Balenghien T., Toty C., Ferré J.B., Thomas C., Dervieux A., L'ambert G., Schaffner F., Bardin O., Fontenille D. 2007. Effects of local anthropogenic changes on potential malaria vector *Anopheles hyrcanus* and West Nile virus vector *Culex modestus*, Camargue, France. *Emerging Infectious Diseases*, **13**: 1810-1815.

Rogers D.J., Randolph S.E. 2006. Climate change and vector-borne diseases. *Advances in Parasitology*, **62**: 345-381.

Scharlemann J.P.W., Benz D., Hay S.I., Purse B.V., Tatem A.J., Wint G.R.W., Rogers D.J. 2008. Global data for ecology and epidemiology: a novel algorithm for temporal Fourier processing MODIS data. *PLoS ONE*, **3**(1): e1408 (13 p.). http://dx.doi.org/10.1371/journal.pone.0001408

Sumilo D., Asokliene L., Bormane A., Vasilenko V., Golovljova I., Randolph S. 2007. Climate change cannot explain the upsurge of tick-borne encephalitis in the Baltics. *PLoS ONE*, **2**(6): e500 (11 p.). http://dx.doi.org/10.1371/journal.pone.0000500

Tersago K., Schreurs A., Linard C., Verhagen R., Dongen S.V., Leirs H. 2008. Population, environmental, and community effects on local bank vole (*Myodes glareolus*) Puumala virus infection in an area with low human incidence. *Vector Borne and Zoonotic Diseases*, **8**: 235-244.

Tran A., Ponçon N., Toty C., Linard C., Guis H., Ferré J.B., Seen D.L., Roger F., de La Rocque S., Fontenille D., Baldet T. 2008. Using remote sensing to map larval and adult populations of *Anopheles hyrcanus* (Diptera: Culicidae) a potential malaria vector in southern France. *International Journal of Health Geographics*, **7**: 9.