FOREST ECOSYSTEM SERVICES FOR SUSTAINABLE DEVELOPMENT IN A PROTECTED AREA

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Abstract: *In recent years there have been several attempts to record all the ecosystem services that can be provided by a forest. There are several classification schemes for ecosystem services with more representative ones MA (The Millennium Ecosystem Assessment), TEEB (The Economics of Ecosystems and Biodiversity) and CICES (The Common International Classification of Ecosystem Services). The concept of ecosystem services is linked with the contribution of the structures and functions of ecosystems to the maintenance and improvement of the quality of human life. Understanding this link is critical for a wide range of decision-making frameworks. National parks are protected areas by law and no intervention is allowed in their core. The Dadia - Lefkimi - Soufli National Forest Park is one of the most important protected areas at national, European, and international level. Opinions of mild interventions are expressed for the sustainable development of the wider area of the National Park, through systematic information, effective dialogue and promotion of strategic alliances between all political, productive and social actors that directly or indirectly influence the formation of spatial development options. Such views mean: ensuring equal living conditions and productive employment opportunities for citizens in this semi-mountainous region of the country, depending on their balanced structure of the population and demographic renewal, upgrading the quality of life of citizens and improving infrastructure, especially when there are problems of lagging development and environmental degradation, preservation, improvement, and promotion of residential and productive diversity, as well as natural diversity, with an emphasis on alternative crops, systematic protection, restoration, conservation and promotion of areas, settlements, landscapes, with natural elements, cultural and architectural heritage.*

Key words: *National Forest Park, MA, TEEB, CICES, cultural and architectural heritage.*

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1. Introduction

Ecosystems are stocks of natural capital that provide flows of tangible or intangible benefits for human welfare [5]. These benefits known as ES cover a wide range of products and services, as well as functions that sustain the ecosystems [8]; the body of knowledge on ecosystem services is very large but there is a general consent that important information on ecosystem services is still lacking. Parts of the environment in which the humans are developing their activity are characterized by various types of ecosystems. One way to account for landscape utilization, therefore, to manage the environment, which in turn may help in developing policies and strategies for a sustainable use, is that of using the concept of ecosystem services [6].

The Ecosystem Services (ES) concept has become increasingly popular in the last decades and it is usually employed to emphasize the contributions of ecosystems to human welfare. Although the recognition of the capacity of natural systems to provide benefits to society was already present, the concept of ES provides a framework where the contribution of ecosystems to societal wellbeing is highlighted.

Furthermore, this approach calls for a more fundamental multidisciplinary focus, promoting a dialogue between biology and economics [9] by considering both the ecological production and the economic value [2]. It allows to be distinguishing the contribution of benefits to society supplied by ecosystems from those provided by human capital or labour [1, 3], offering a framework to link changes in ecosystem processes and outputs to its effects on social welfare.

The most popular and widespread definition of ES is the one that is given by Burkhard and Maes [4] who stated that ES mean the contribution of the structures and functions of ecosystems in maintaining and improving the quality of human life.

According to several classification systems, ecosystem services belong to categories such as those encompassing provisioning, regulation, cultural and supporting services. Nevertheless, the provision of these services to a great extent depends on the existing biophysical conditions and the changes in space and time due to human-induced land cover change, land use and climatic changes, with rural people being the most vulnerable to such changes [10, 11].

The most common classification systems of ecosystem services are the: MEA (The Millennium Ecosystem Assessment), TEEB (The Economics of Ecosystems and Biodiversity), and CICES (The Common International Classification of Ecosystem Services).

According to MEA [10], ecosystem services are divided into four categories:

- Provisioning services are the products people obtain from ecosystems, such as food, fuel, fiber, fresh water, and genetic resources;
- Regulating services are the benefits people obtain from the regulation of ecosystem processes, such as air quality maintenance, erosion control or water purification;
- Cultural services are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development,

recreation, and aesthetic experiences;
- Supporting services are those that are necessary to produce all other ecosystem services such as primary production, and soil formation.

TEEB is a global initiative focused on "making nature's values visible" [12]. According to TEEB [12], ecosystem services are divided into four categories, which are then divided into 22 subcategories [7]:

- Provisioning services;
- Cultural services and Amenity;
- Regulating services;
- Habitats services.

CICES provides a framework for classifying final ecosystem services that are dependent on living processes (biodiversity). CICES divides forest ecosystem services into [13]:

- Provisioning;
- Cultural;
- Regulation & Maintenance.

All the above systems recognize that forests, like other ecosystems, supply us with material goods that are difficult to find from other sources. These goods can be exchanged, traded, or consumed directly. These include wood, mushrooms, berries, aromatic and medicinal plants, prey, and biofuels.

Forests provide cultural services. They contribute to tourism and leisure. They increase the aesthetic value of an area and have a positive effect on the psychosynthesis of people who come even in visual contact with them. They are part of the folklore and traditions of every country.

Forests contribute to the regulation of the climate, temperature, water balance and wind speed. They protect against floods and erosion.

But the most important service offered by forests is related to the conservation of biodiversity. Biodiversity contributes to the stability of a system. The more components a system has, the less impact it receives by the alteration of one of them. In Greece, but also throughout Europe, the protection of biodiversity was favoured by the establishment of the European network of protected areas Natura 2000. Especially for the forests of Greece, a remarkable effort has been made to assess in economic terms the value of the services they offer.

Forest ecosystems are increasingly being influenced by human activity, including rapid expansion of urban land cover, which may alter forest processes, functions, and the ecosystem services that can be provided by a forest.

We still have relatively little understanding about the provision of forest ecosystem services notwithstanding the number of studies assessing the services provided by these ecosystems is constantly increasing.

The aim of this paper was to evaluate the forest ecosystem services of a protected area for a rational and sustainable development of it through mild intensity developmental measures.

2. Material and Methods

2.1. Research Area

The Dadia - Lefkimi - Soufli National Forest Park covers an area of 36,035.01 ha (Figure 1) and is lied between 40°58′00′′ to 41°15′00′′ N and 26°58′00′′ to 26°19′00′′ E (Table 1). The Dadia - Lefkimi - Soufli National Forest Park is broken down by land uses as shows in Table 2 (Figure 2).

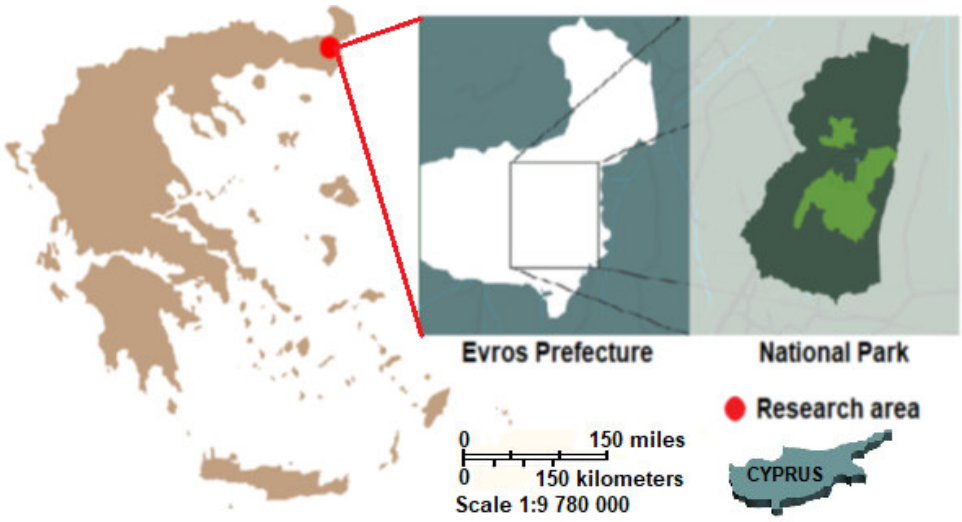

Fig. 1. *Research area*

Table 1

The boundaries of the Dadia – Lefkimi – Soufli National Forest Park

Bordered on	Bounded by
North	The borders of the former Communities Mandra, Protokklisiou, kiriaki and the boundaries of the forest Deriou – Aisymis
South	The borders of the former CommunitiesArdanio, Kavissou – Pilea
East	The National Road Alexandroupolis – Soufli – Orestiada
West	The administrative boundaries of the former Community Aisymis and the boundaries of the forest Deriou – Aisymis

Table 2

The Dadia – Lefkimi – Soufli National Forest Park's land uses

Serial Number	Land uses	Area [ha]	Percentage [%]
1	Forested areas	18,518.37	51.40
2	Partially forested areas	5,404.80	15.00
3	Evergreen and broadleaved	992.32	2.75
4	Agricultural lands	7,841.66	21.76
5	Barren lands, bare lands, firebreaks	2,965.70	8.23
6	Settlements	290.74	0.81
7	Dams and reservoirs	21.43	0.05
Total		36,035.01	100.00

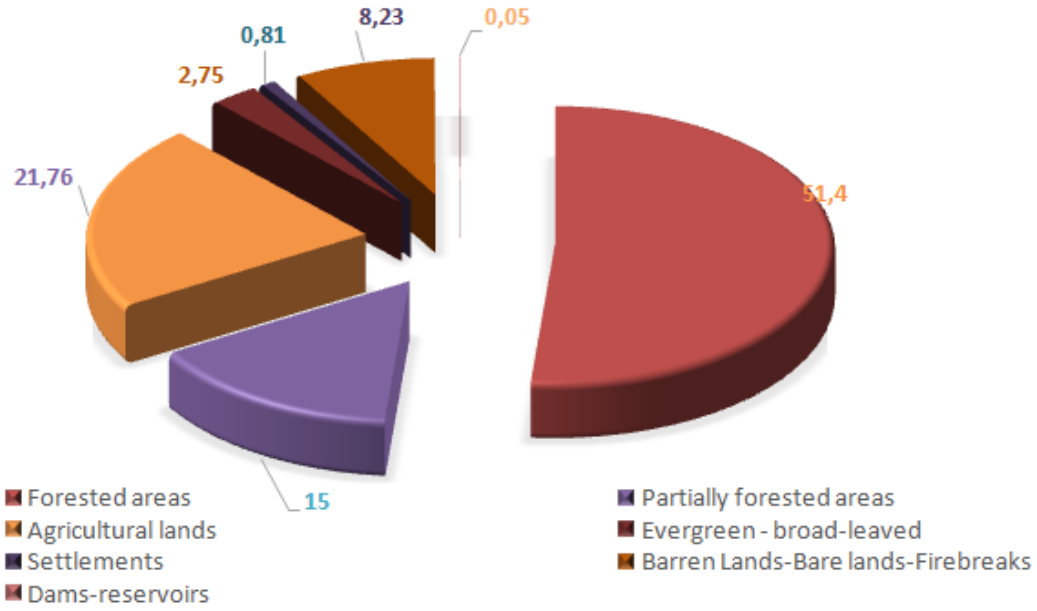

Fig. 2. *The Dadia - Lefkimi - Soufli National Forest Park'sland uses*

2.2. Description of the Ecosystem Services Derived from Natural or Ecological Environment

The landscape of Dadia - Lefkimi - Soufli National Forest Park is covered mostly by woodlands. The terrain is characterized by a turnover of small and large valleys, gentle and steep slopes, as well as a diverse hydrographic network with small and large streams. There are five major temporary torrential streams flows from W and NW and E and SE to the Evros River. During the summer, most of these streams retain pools of water supplying with clear water the entire region of the National Forest Park for humans, animals, and vegetation. The highest peak of the National Forest Park is Kapsalo at 620 m.

The climate of the region under study is Mediterranean (meso-Mediterranean), but its Mediterranean character is significantly modified by prevailing northern winds which gives a regionally harsh winter climate with continental affinities (Purification of air and water).

The area of the National Park presents a rich and diverse flora with species typically met in the Eu-Mediterranean and Para-Mediterranean vegetation zones. The composition of the forest, that covers the greatest part of the National Park, has been shaped in accordance to the climatic conditions in the area, geomorphology, soil and proximity to the Evros River (Regulation of water level – Protection of droughts and floods, Timber products – fuel wood and timber). Pine trees predominate in the area of the National Park, forming coniferous forests of Turkish pine (*Pinus brutia* Ten.), with black pine (*Pinus nigra* J.F. Arnold) found at the lowest altitudes of its known distribution, while forests of oak trees such as the Broadleaved oak (*Quercus frainetto* Ten.), the Turkey oak (*Quercus cerris* L.) and the Downy oak (*Quercus pubescens* Wild.) also occur over a large expanse together with maquis shrublands. Sclerophyllous shrubs,

such as the Greek Strawberry tree (*Arbutus andrachne* L.), the Phillyrea (*Phillyrea latifolia* L.), the Treeheath (*Erica arborea* L.) and the Cretan rockrose (*Cistus creticus* L.) are mainly found in the south-western area along with 25 orchid species scattered throughout the National Park. At the south-western part of the National Park survives a small deciduous tree - the *Eriolobus trilobatus* (Poir.) C.K. Schneid (wild apple tree). This tree can be found only in Evros, having a low population of 150 trees. It is classified in the category of the rare and endangered species of the European flora. In what regards the riparian vegetation, the common Black alder (*Alnus glutinosa* (L.) Gaertn.) dominates most sites, while in others the Willow (*Salix spp.*), the Black poplar (*Populus nigra* L.) and the Athel tree (*Tamarix aphylla* (L.) Karst.) stand out (Non-timber products – medicine – roots – leaves, Biodiversity, Recreation and tourism – photography, Scientific field – for universities).

The rich combination of the landscapes creates an ideal biotope for the predator birds (Biodiversity). In the area are hosted 36 of the 38 European birds of prey, including rare species like the Eastern Imperial Eagle (*Aquila heliacal* Savigny) and the Lesser Spotted Eagle (*Aquila pomarina* Brehm). The Dadia - Lefkimi - Soufli National Forest Park is one of the unique areas in Europe where a high number rare species live together and also is the unique area where 3 of the 4 different species of vulture exist together: the Cinereous Vulture (*Aegypius monachus* Linnaeus), the Griffon Vulture (*Gyps fulvus* Hablizl) and the Egyptian Vulture (*Neophron percnopterus* Linnaeus) of Europe. The forest is the home for 20 couples of the Cinereous Vulture, and they are the only population in the entire south-eastern Europe. Also, it hosts approximately 60-65 mammal species (8 species are internationally recognized as endangered species) such as the wolves, bears, roe deer, otter, wildcat, wild boar (*Sus scrofa* Linnaeus), the stone marten (*Martes foina* Erxleben), the weasel (*Mustela nivalis* Linnaeus), the badger, squirrels, bats, and 41 reptile and amphibian species. Also, 17 different fish species have been recorded and 283 species of invertebrates were identified, 104 of which are butterflies.

2.3. Methodology

The methodology steps are the following:

1. Carrying out field investigation with data collection, based on sampling method and description of the stands. On the spot investigation of the existing conditions (Location and boundaries of the forest, forestry species composition, forest structure, management form, management classes, and access roads, facilities and settlements, etc.). For the field measurements were used GPS, compass, clinometer, and measuring tape;
2. Search and collection of the primary and secondary data from various stakeholders or from either public corporations or private organizations with the help of questionnaires and private interviews:
   - Data collection from municipalities (Socioeconomically-census data, grazing, hunting, tourism, protection etc.) with the help of questionnaires and private interviews;

- Data collection from Forest Service (meteorological data, ownership conditions, maps, data of prior management etc.) with private interviews;
- Cartographic and aerial material from the Military Geographical Service and the Ministry of Rural Development and Food (Topographic maps of various scales, recently taken aerial photos, orthophotomaps).

3. The methodology is that of the questionnaire, the results of which were stored in databases and in a geographic information system (ArcGIS); the data were processed (qualitatively and quantitatively), in order to propose possible and feasible solutions for the expected sustainable development of the area. The questionnaires were distributed to the residents in the area and were aimed to record both their professional and financial situation, as well as their views on the study issues. Taking into account the geographical location of Dadia - Lefkimi - Soufli National Forest Park, the terrain, the climate and the infrastructure that exist, it is possible for the geographic information systems to interconnect all levels of information (quantitative, qualitative, cartographic etc.). As a result, spatial maps can be created by combining the above depending on the case;
4. Drawing up conclusions and proposing policy measures to address conservation and the integrated sustainable development and management of the multifunctional GI protected areas in Greece.

3. Results and Discussion

3.1. Description of the Ecosystem Services Derived from Human Environment

The population of the three municipal departments of Dadia, Soufli, Likofi, Lagina, Lefkimi and Kornofolia amounts to 15,365 inhabitants. A series of local activities, endogenously driven and based upon local resources and practices still exist to give the area its present economic character. The main residents' occupations are agriculture, livestock farming, forestry (logging), viticulture, sericulture, beekeeping and lately, tourism (ecotourism).

Logging and forest management of the National Park have been interlinked with the residents' life for many years. Many residents cultivate the land, either as their main occupation, or in order to enhance their income. Viticulture along with sericulture have constituted the two main activities of the inhabitants of Soufli and of the wider region, bringing economic and demographic growth. Some silk craft industries and several commercial businesses operate in Soufli. Livestock farming activity is gradually dying out year after year nonetheless there are still animals freely grazing. Beekeeping holds a prominent position in the region, and it is dynamically growing in the wider area of the National Park. It is estimated that more than 100 tones of honey are produced per year (Food of vegetable origin, food of animal origin, timber products and non-timber products).

The outdoor recreation facilities are few, confined to the vulture feeding site and a couple of trekking paths and visitor services are rather poor. In "Katratzides", 9 km from Dadia, is a place for various

sports and outdoor living facilities. Additionally, there are some ecotourism facilities (Recreation and tourism).

3.2. Description of the Ecosystem Services Derived from Cultural Environment

In the Dadia - Lefkimi - Soufli National Forest Park, which is under study in this paper, one can visit the information centre in order to have some information about the area and the diversity especially for the population of birds of prey and of course to see the observation post of them (birds of prey). The area's cultural history is manifested in e.g., a high number of sites of cultural and archaeological importance scattered over the area. The village of Dadia is a traditional settlement, featuring the monastery and old church of Prophet Elias. In the nearby Lefkimmi village, there is the 16th century church of Virgin Mary. Also, there are village ruins, stone-bridges, and various remains of ancient fortifications, mainly of Iron Age but also early Byzantine era, remnants of ancient settlements and many other historical sites. At the site of Anavra, three marble Roman sarcophagi have been discovered, as well as a carved rock, which according to tradition hosted a Byzantine church. In Lagyna, a stone-built tomb with semicircular arch, of Macedonian type has been discovered, dating back to the 4th century BC. On the top of AdaTepe the foundations of a stone-built fortress with five semicircular towers have been found. Someone can visit Soufli to admire the architecture of the town, the famous cocoon houses and Municipal Museum, Folklore Museum and Silk Art Museum of Soufli.

Special mention must be made of the very well-preserved parts of fossilized trees, which comprised part of a huge forest ecosystem c. 20–25 million years ago. It is considered to be the oldest petrified forest found on Greek territory. This important geological heritage extends today mainly over the low-lying, flat areas along the Evros River and only a small part reaches into the park. Knowledge of the ecological and cultural wealth of the area is a tool for conserving and respecting the area (Recreation and tourism, Scientific field and Ancestral practices and rituals).

In this research area, it is proposed to develop those forms of economic exploitation that are appropriate to its case, and the development intensity must be mild, in order not to have disturbances in the natural environment.

It would be good after considering all the ecosystem services derived from the natural or ecological environment, from cultural and human environment to pay attention to the following mild interventions in the research area:

- The definition of activities according to the management plan that concerns the wider region, to establish the non-management cores and peripheral zones accessible to the public;
- The construction and maintenance of the regional road network;
- Marking of mountain trails with an international trail and publication of special information maps for the information of the visitors;
- Upgrading the hotel infrastructure and services provided by all those involved in tourism professions (restaurants, cafes etc.);
- Establishing incentives for architectural urban planning upgrade;

- Connection of the whole developmental effort with the general one attempted in Greece;
- Promotion and protection of all monuments of the local architectural heritage (bridges, mansions, churches, chapels);
- Establishment of observatories for monitoring wildlife;
- Strengthening of the production of silk and the rearing of silkworms for this purpose and culture as an element of cultural heritage.

4. Conclusions

In summary the main benefits expected are:

- Ensuring a smooth and safe traffic of vehicles;
- Better monitoring, fire protection;
- Improving the competitiveness of forest products by reducing the large costs of handling and marketing;
- Increasing tourist traffic, and
- Strengthening the region's economy by increasing local employment; the stakeholders ought to take strategic decisions about the priorities for the region; these decisions should transfer the strategy into action and plans required for implementation.

The economic characteristics of the Dadia - Lefkimi - Soufli National Forest Park are shaped by many factors pertaining equally to the endogenous characteristics of the area's economy and to national economic importance of this border area. These two economic forces negotiate the development trajectories to be followed by the local economies and are often pulling in strongly diverging directions.

The geographical position gives it a special importance for national defense, but also puts it in the middle of a series of developments aimed at strengthening trade and energy links with neighboring countries. Investments to materialize these nation-wide development targets directly affect employment and economic activity, but also have an impact upon the overall character of the area, often jeopardizing the resources on which local economic activities depend. The establishment of renewable energy infrastructures in the area belongs in the same category of activities. On the other hand, a series of local activities, endogenously driven and based upon local resources and practices still exist to give to the area its present economic character. These activities include agriculture, stockbreeding, forestry and lately, tourism.

Each developmental project was designed to address the specific characteristics and needs (physiognomy) of each area with the least possible negative impacts. Particularly for vulnerable and sensitive semi mountainous areas, integrated development is not only necessary but also feasible.

References

1. Bateman I.J., Mace G.M., Fezzi C. et al., 2011. Economic analysis for ecosystem service assessments. In: Environmental and Resource Economics, vol. 48(2), pp. 177-218.
2. Bauer D.M., Johnston R. J., 2013. The economics of rural and agricultural ecosystem services: purism versus practicality. In: Agricultural and

Resource Economics Review, vol. 42(1), pp. III-XV.
3. Brown T.C., Bergstrom J.C., Loomis J.B., 2007. Defining, valuing and providing ecosystem good and services. In: Natural Resources Journal, vol. 47(2), pp. 329-376.
4. Burkhard B., Maes J. (Eds.), 2017. Mapping Ecosystem Services. Pensoft Publishers, Sofia, Bulgaria.
5. Calvet-Mir L., Gomez-Baggethum E., Reyes-Garcia V., 2012. Beyond food production: Ecosystem services provided by home gardens. A case study in VallFosca, Catalan Pyrenees, Northeastern Spain. In: Ecological Economics, vol. 74, pp. 153-160.
6. Castillo Vizuete D.D., Gavilanes Montoya A.V., Ricaurte Yepez C.B. et al., 2019. Perception and use of cultural ecosystem services among the Andean communities of Chimborazo reserve. In: Journal of Environment Engineering and Management, vol. 18(12), pp. 2705-2718.
7. de Groot R., Fisher B., Christie M. et al., 2010. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. In: The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations (ed. Kumar, P.). Earthscan, pp. 1-40.
8. Gavilanes Montoya A.V., Castillo Vizuete D.D., Morocho Toaza J.M. et al., 2019. Importance and use of Ecosystem Services provided by the Amazonian landscapes in Ecuador – Evaluation and spatial scaling of a representative area. In: Bulletin of the Transilvania University of Brasov, Series II: Forestry - Wood Industry – Agricultural Food Engineering, vol. 12(61), no. 2, pp. 1-26.
9. Lele S., Springate-Baginski O., Lakerveld R. et al., 2013. Ecosystem services: origins, contributions, pitfalls, and alternatives. In: Conservation and Society, vol. 11(4), pp. 343-358.
10. MEA, 2005. Millennium Ecosystem Assessment. Ecosystems and human well-being: wetlands and water. Online at: https://sci-hub.tw/10.1016/b978-0-12-409548-9.09206-x. Accessed on: 25 May, 2021.
11. Riitters K.H., Wickham J.D., Vogelmann J.E. et al., 2000. National Land-Cover Pattern Data. In: Ecology, vol. 81(2), p. 604.
12. TEEB, 2008. The Economics of Ecosystems and Biodiversity: An Interim report. Available online at: www.teebweb.org. Accessed on: 2 October, 2020.
13. Turkelboom F., Raquez P., Dufrêne M. et al., 2013. CICES going local: Ecosystem services classification adapted for a highly populated country. In book: Ecosystem Services: Global Issues, Local Practices (eds. Sander Jacobs, Nicolas Dendoncker, Hans Keune). Boston, pp. 223-247.