



Current status and characteristics of the Ecological and Natural Map in the Republic of Korea

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The integration and management of various national ecological assessments are essential for the benefit of the public. In the Republic of Korea, the Ecological and Natural Map (ENM) serves as a comprehensive platform that synthesizes the results of national ecosystem surveys into a unified system interface. To provide the current status and characteristics of our policy, we analyzed the ENMs and related appeals from 2014 to 2022. Following their implementation, the ENM Guidelines underwent nine revisions, with most of the revisions pertaining to appeals. Nine public announcements were made regarding the ENM, resulting in a gradual expansion of the conservation area. The data also showed a consistent increasing trend in appeals. Most of the 1st-grade areas in the ENM regions where appeals were filed have significantly decreased. The larger area or the smaller population density of an administrative district, the more appeals were filed. Our study presents information regarding the current status of the ENM system. The analysis of the operational direction and indicator trends across the 16-year period since the establishment of the system provides valuable insights for similar systems.

Keywords: conservation area, national development management, policies and stakeholders

Introduction

National ecosystem assessments (NEAs) are designed to provide policymakers with comprehensive information about the state of a nation's environment and the potential risks it faces (Schröter et al. 2016). These tools can contribute to various aspects of ecosystem management, including the following: (1) conducting an accurate assessment of the current state of a nation's ecosystems; (2) assessing the potential risks and challenges faced by these ecosystems; (3) developing effective strategies for the conservation and restoration of ecosystems; and (4) informing decision-making processes influencing public policy. NEAs have been conducted in several countries, such as the United States of America, the United Kingdom, Portugal, Finland, and Germany (Albert et al. 2016; Jäppinen and Heliölä 2015; MEA 2005; Pereira et al. 2013; UK National Ecosystem Assessment 2011). Recently, China proposed a method to evaluate natural value using gross ecosystem product (Ouyang et al. 2020). The Europe's NEAs are very important as basic data in assessing current ecosystems and ecosystem services. There were providing knowledge on policy-related questions about ecosystem sustainability

(Schröter et al. 2016).

Ecosystem assessment methods can be divided into four distinct categories. Observational methods involve the systematic collection of data on the structure and function of an ecosystem, devoid of any alteration or manipulation. This can be achieved using field surveys or remote sensing (Kim et al. 2015; Ko et al. 2019). Experimental methods involve the manipulation or alteration of ecosystems with the purpose of testing their responses to various stressors. This can be achieved by conducting controlled experiments in a laboratory or manipulating the ecosystem in the field (La et al. 2009). Modeling methods use mathematical models to simulate ecosystem behavior. It can be used to predict the response of ecosystems to different stressors or assess the value of ecosystem services (Kim et al. 2019). Indicator-based methods use a set of indicators to evaluate ecosystem conditions. Indicators can be physical, biological, or social and can be used to track changes in ecosystem conditions over time (Hong et al. 2017). Specific ecosystem assessment methods can also be divided into three categories: biodiversity, ecosystem health, and ecosystem service assessments (Hong et al. 2018; Ko et al. 2020; MEA 2005). These methodologies evaluate the ecosystem in three dis-



tinct manners: (1) using the dynamics of populations or communities; (2) using indicators such as keystone species; and (3) measuring the economic value of the ecosystem. Ecosystem assessment is an important tool for understanding the state of specific ecosystems and sustainably managing them.

In the Republic of Korea, NEAs are frequently conducted using observational methods to monitor natural changes. A representative example includes the survey on natural environment (SNE), which has been conducted annually across the country since 1986 by the Ministry of Environment (ME), the National Institute of Environmental Research (NIER), and the National Institute of Ecology (NIE) to identify the current status of the natural environment and accumulate biological resource data (Rho and Choung 2006). In addition, the Winter Waterbird Census of Korea has been conducted since 1991, which is similar to the Christmas Bird Count in the United States of America (NIBR 2022). This is based on the geological importance of Korea as a major stopover point along the East Asian-Australasian Flyway. The NIER conducts national surveys, such as assessments of the health and current status of aquatic ecosystems, in order to monitor freshwater ecosystems (Water Environment Conservation Act). The NEAs in the Republic of Korea are conducted using various methodologies that encompass various criteria, such as individuals, populations, indices, and endangered species.

It is important to ensure a comprehensive expression of NEAs. Because the metadata gathered from annual research projects are assigned attributes such as points or polygons in geographic coordinates, they can be integrated into a geographic information system database in the form of spatial information to improve their usability (NIE 2022). Accordingly, the data collected by the ME and its affiliated organizations are consolidated and utilized to

create a comprehensive map known as the Ecological and Natural Map (ENM). This tool provides ecological information based on national research on the natural environment and facilitate scientific administration in order to meet the public's right to access information.

The purpose of this study is to present an overview of the status of the department responsible for the ENM system and outline the characteristics of each type of appeal, with the aim of making revisions to the map. Our study serves as an important model for future research efforts at the national level that consider both environmental conservation and socioeconomic development.

Materials and Methods

Assessment area

The Korean Peninsula, situated between China and Japan, is depicted in Fig. 1. The Republic of Korea covers a surface area measuring 100,412.6 km². The ENM dataset consists of 800 map sheets, each of which is made up of rectangular regions measuring 1.2 × 13.8 km in size (Fig. 1), with the exception of those depicting the marine area.

Ecological and Natural Map

ENM refers to a map created by grading the natural environment of the Republic of Korea based on its natural characteristics and ecological and landscape values (Natural Environment Conservation Act [NECA], Article 2). ENMs are divided into first-grade zones (e.g., conservation and restoration), second-grade zones (e.g., minimization of damage), third-grade zones (e.g., development and utilization), and distinct management zones (DMAs; e.g., forest conservation zones and natural parks) (Enforcement Decree of the NECA, Articles 25 and 28; Fig. 1). First, second,

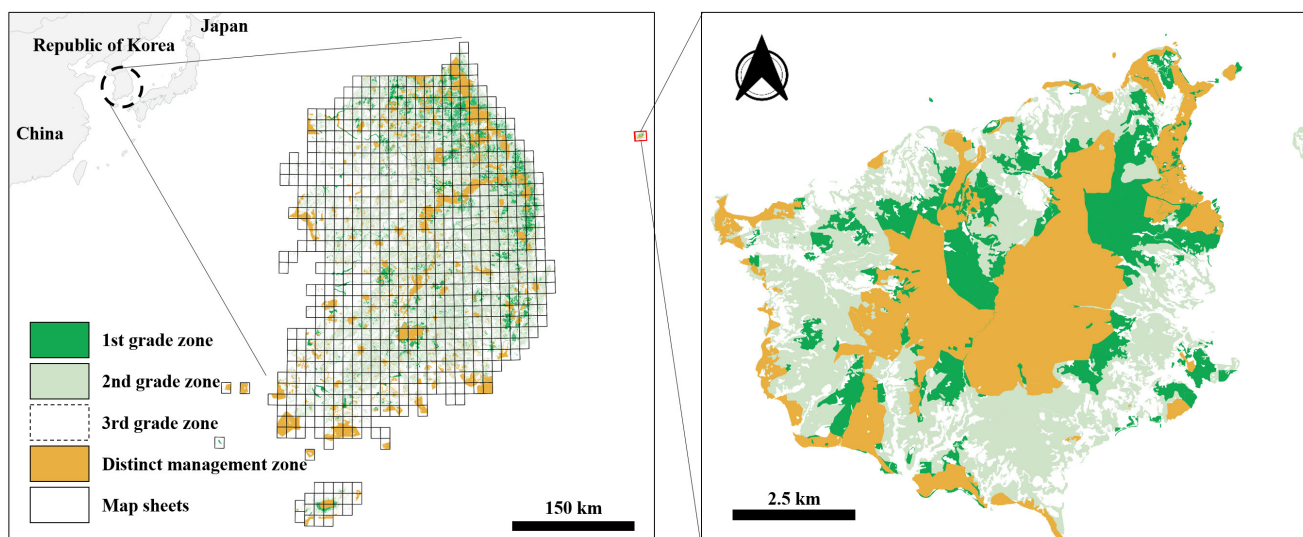


Fig. 1 Geographical location of Republic of Korea and spatial range of the Ecological and Natural Map consisting of 800 map sheet. On the right is a specific example of an Ecological and Natural Map (Ulleungdo).

and third grades in the ENM were composed of data surveyed and evaluated by expert. Specifically, 1st-grade areas are areas with (1) excellent vegetations (vegetation conservation grade I, II), (2) habitats for endangered wildlife, (3) wetlands for large-scale migratory birds, (4) areas near the wetlands (buffer zones), and (5) an excellent topographical scenery (terrain conservation grade I). 2nd-grade area refers to an area that does not correspond to a 1st-grade area but has a natural ecosystem. 3rd grade area applies to areas excluding 1st, 2nd grade areas and DMA. DMAs are areas preserved under other laws. 1st-grade areas of ENMs are produced on a minimum scale of 1:25,000 using data from 14 survey projects, which include the SNE (NECA, Article 34; ENM Guidelines). These surveys undergo annual revisions and are made publicly accessible on a designated website (<https://egis.me.go.kr/>).

The ENM is drafted, publicly announced, freely appealed, and subsequently revised in accordance with the “ENM Guidelines.” In this study, the changes in the ENM Guidelines from 2014 to 2022, when the NIE was entrusted with ENM responsibilities, were compared.

Data collection

The ENM regularly announces the completed map sheets for SNE projects. We classified the areas according to grade based on eight public announcements (PAs) from the initial ENM distribution (2007) to 2022 (2013, 2015, 2016, 2017, 2018, 2020, 2021, and 2022).

Appeals are received by the ecospatial information management and mapping team at the NIE in order to partially revise the ENM. Our team has continuously established a database to manage the history of appeal cases (Table S1), using appeal data from 2014 to 2022. Each appeal was categorized as (1) subject (public or civil), (2) received (accepted or rejected), or (3) grade change (upward, new, maintain, downward, and DMA). Grade changes were based on the increase or decrease in 1st-grade areas prior to and following the appeal. Specifically, (1) upward denotes an increase in 1st-grade area; (2) new represents the creation of 1st-grade areas from appeals from 2nd or 3rd grade areas; (3) maintain indicates an area in which 1st-grade areas remain unchanged (including rejected appeals); (4) downward represents a decrease in 1st-grade areas (including when appeals from 2nd-grade areas were downgraded); and (5) DMA denotes changes in the ENM area owing to the designation and cancellation of DMAs.

In addition, the appeals were classified in accordance with the following criteria: region-specific population as resident registration population status as of June 2023 (<https://kosis.kr>; Ministry of the Interior and Safety), urban planning status area in 2021 (<https://kosis.kr>; LX), population density (ind./km²), and 1st-grade area rate (%) (Choi et al. 2019). We sought to discover the relationship between the four regional characteristics and appeals.

Analysis

ArcGIS Pro version 3.0.1 software (Esri Inc., Redlands, CA, USA) was used to calculate the change in area for each renewal announcement in the ENM. We confirmed the trend of area change by ENM grade using PAs and the number of appeals per year using a Mann–Kendall (MK) test. MK tests were performed using the Paleontological Statistics program version 4.05 (Hammer et al. 2001). Kendall’s Tau-B test was used to test for a correlation between number of appeals and (1) population, (2) area, (3) population density, and (4) 1st-grade rate of each administrative district using R 4.3.1. software (<https://cran.r-project.org> [accessed on 19 November]). Data was converted to the ordinal scale (descending order). All statistical tests were conducted with a significance threshold set at $p < 0.05$.

Results

Contents for revision in Ecological and Natural Map Guidelines

The ENM Guidelines were enacted in 2000 and revised nine times (Table 1). Among them, there were a total of five revisions from 2014 to 2022, which were transferred to the NIE.

The 2015 revision was made to improve and supplement the problems raised during the ENM drafting process and contained four main components. First, the timing of the application and the PA of the SNE results were adjusted from a “five-year cycle” to “within two years from the end date of the survey.” Second, the Grade V vegetation conservation grade was excluded when evaluating endangered wildlife habitats (lattice markings). Third, the results of the Natural Environment Survey (NES) were omitted in the case of vegetation conservation grade V areas, which could be checked with the most recent image data when filing an appeal regarding a change in ENM grade. Finally, the NECA (Enforcement Decree, Article 52-2) was revised to delegate the drafting of the ENM to the NIE, and the managing main agent of the ENM Advisory Committee was changed from the ME to the Director of the NIE.

The main purpose of the revised ENM Guidelines in 2018 was to simplify the NES requirements for appeals to the ENM. In order to minimize costs for the appealing party and expedite the preparation period for the appeal, the investigation period was shortened from “more than two seasons” to “more than one season.” Furthermore, the scope of the investigation was reduced from “within 500 m” to “within 250 m” from the boundary of the appeal. In addition, as part of the ENM revision process, the public inspection period was extended to 45 days, and the appeal processing deadline was extended from “within 60 days” to “within 90 days.” Moreover, the subject of the appeal was limited to the landowner or the person who obtained the

Table 1 History of the Ecological and Natural Map Guidelines (<https://law.go.kr>)

No.	History	Main revised contents
1	2000.11.07. (enactment)	-
2	2004.10.19. (partial revision)	-
3	2009.01.15. (partial revision)	-
4	2009.08.18. (revision of other laws)	-
5	2014.01.19. (partial revision)	Performance of entrustment of work (National Institute of Ecology)
6	2015.07.17. (partial revision)	Adjustment of the announcement period Improvement of preparation criteria for first-grade zones Simplification of appeal documents Change of the managing main agent for the Advisory Committee
7	2018.12.31. (partial revision)	Simplification of the objection procedure Improvement in the accuracy of survey data
8	2020.11.23. (partial revision)	Division of announcement (“renewal announcement” and “nonscheduled announcement”)
9	2021.03.18. (partial revision)	Creation of the ENM of areas (border areas) that are difficult to investigate Stipulation of survey projects that need to reflect the ENM Establishment of a mandatory period for announcement Stipulation of processing deadline for an appeal Notification of supplementary submission of appeal documents
10	2023.04.06. (partial revision)	Stipulation of the timing of the renewal announcement (annually in February) Clarification of the contents of the Natural Environment Survey Report on appeals Stipulation of considerations when selecting a survey taxonomic group

ENM: Ecological and Natural Map.

landowner’s consent, and the minimum area (i.e., minimum area for grade evaluation) was reduced from 62,500 m² to 2,500 m² for a detailed division of areas.

In the 2020 revision, the definition of “announcement” was subdivided into “renewal announcement” and “non-scheduled announcement” in order to elucidate the procedures for appeals and announcements. The term “renewal announcement” referred to the PA of the ENM in the official gazette that reflected the SNE, whereas the term “non-scheduled announcement” referred to the re-notification of the ENM in the official gazette that reflected the results of the on-site survey of the previously announced ENMs. In addition to the definition, procedures tailored to each PA were newly established, and the appeal processing period was specified as “within 120 days (request for announcement)” in order to estimate the completion schedule.

The 2021 revision was designed to improve the accuracy of the ENM and contained five main parts. First, if it was too difficult to conduct field surveys, such as in frontier areas, literature data were used to prepare ENMs. Second, the investigation project specifically stated this, which was reflected in the drafting of the ENM. Third, if the data on the appeal were insufficient, written notice should be given of a request for the submission of additional data. Fourth, when the ME received a request to disclose the ENM (draft), it was required to provide notification of such a request within 30 days. Finally, it was stipulated that if an on-site investigation could not be conducted during the biological season, it should not be included in the processing period.

Area changes in the Ecological and Natural Map

The ENM was renewed nine times (Table 2). The pro-

portion of 1st-grade areas ranged from a minimum of 7.4% to a maximum of 9.2%. The proportion of 2nd-grade areas ranged from a minimum of 39.3% to a maximum of 45.4%. The proportion of 3rd-grade areas ranged from a minimum of 36.9% to a maximum of 44.6%. The proportion of DMA areas ranged from a minimum of 8.6% to a maximum of 10.8%. The 1st-grade area ratio showed an increasing trend (MK test, $S = 22$, $p = 0.012$). The combined area ratio of 1st-grade areas and DMAs designated as conservation areas also exhibited a strong increasing trend (MK test, $S = 31$, $p < 0.001$).

Characteristics of appeals

There were 820 appeals received from 2014 to 2022. We ultimately used 781 appeal cases after excluding the 39 appeals that were repeated. Public and civil appeals involved 187 (23.9%) and 594 cases (76.1%), respectively (Table 3). The highest number of appeals was received in 2018 (i.e., 160 appeals), whereas the lowest number of appeals was received in 2015 (i.e., 42 appeals).

The subjects could reject appeals on the grounds of insufficient preparation. Every year, an average rate of $21.9\% \pm 7.3\%$ civil appeals failed to be received. In particular, out of the 160 civil appeals filed in 2018, 81 cases (50.6%) were rejected. Nevertheless, the number of appeals normally received increased markedly each year (Fig. 2; MK test, $S = 23$, $p = 0.006$).

Grade changes were as follows: upward 1.4% (11 cases), new 0.3% (2 cases), maintained 26.9% (210 cases, including 26.0% [203 cases] rejected), downgraded 67.7% (529 cases), and DMA 3.7% (29 cases) (Table 3). Because 1st-grade areas on the ENM emphasize the conservation and resto-

Table 2 Changes in area of the Ecological and Natural Map by PA and grade (km²)

Year of PA	Ecological and Natural Map							
	Area (km ²)				Ratio (%)			
	1st	2nd	3rd	DMA	1st	2nd	3rd	DMA
2007	7,310.1	38,988.0	44,185.0	8,646.0	7.4	39.3	44.6	8.7
2013	7,360.1	42,807.4	40,386.3	8,584.9	7.4	43.2	40.7	8.7
2015	7,405.4	43,598.3	39,591.1	8,543.9	7.5	44.0	39.9	8.6
2016	8,800.9	44,413.6	37,397.9	8,526.2	8.9	44.8	37.7	8.6
2017	9,000.7	44,998.4	36,626.9	8,512.7	9.1	45.4	36.9	8.6
2018	9,109.9	44,009.9	37,245.7	8,773.2	9.2	44.4	37.6	8.8
2020	9,139.0	42,893.8	38,096.2	9,009.6	9.2	43.3	38.4	9.1
2021	9,093.8	39,554.1	40,100.1	10,390.6	9.2	39.9	40.4	10.5
2022	8,644.9	38,985.2	40,785.1	10,723.5	8.7	39.3	41.1	10.8
Average	8,429.4	42,249.9	39,379.4	9,097.0	8.5	42.6	39.7	9.2

PA: public announcement; DMA: distinct management area.

Table 3 Overview of annual appeals received from 2014 to 2022

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total appeals (n = 781)	43	42	50	83	160	107	79	124	93
Subject (n = 781)									
Public (n = 187)	6	13	8	15	38	24	24	36	23
Civil (n = 594)	37	29	42	68	122	83	55	88	70
Received (n = 781)									
Accepted (n = 578)	38	37	46	63	79	80	64	98	73
Rejected (n = 203)	5	5	4	20	81	27	15	26	20
Grade change (n = 781)									
Upward (n = 11)	0	1	2	0	3 (1)	3	0	0	2
New (n = 2)	0	0	0	0	1	1	0	0	0
Maintain (n = 210)	5	6	4	20	82	28	15	27	23
Downward (n = 529)	38	35 (1)	40	50 (2)	68 (2)	75 (2)	62 (4)	94 (5)	67 (4)
DMA (n = 29)	0	0	4	13	6	0	2	3	1

Appeals that have been “rejected” are included in the “maintain” grade. The numbers in parentheses represent changes in the 2nd-grade cases. Detailed descriptions of each item are written in the data collection section.

DMA: distinct management area.

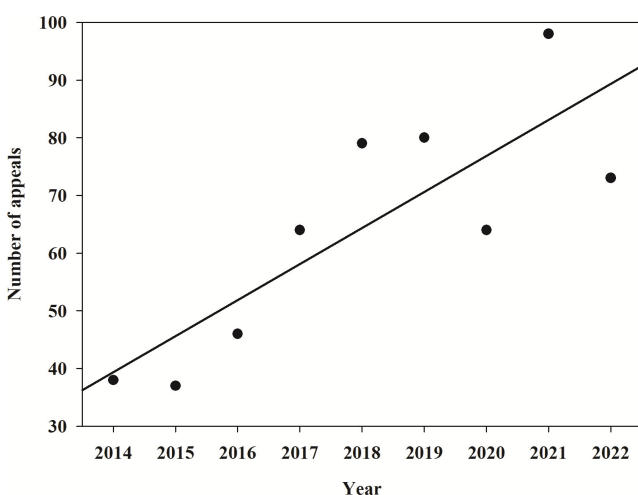


Fig. 2 Mann–Kendall test results for annually accepted appeals, excluding those that were rejected. Black dots were number of appeals accepted per year. Black line is a trend ($S = 23$, $p = 0.006$).

ration of the natural environment, the purpose of the appeal is mainly to downgrade 1st- to 2nd- or 3rd-grade areas via a detailed investigation. Accordingly, it can be con-

firmed which downgrade rate is the highest. When rejected appeals were excluded, the rate of downgraded ENMs accounted for 91.5% of the total.

The average decline rate in the 509 ENM 1st-grade areas classified in the “downward” category was 89.4% (Fig. 3). In particular, 71.5% of 1st-grade areas that filed appeals completely disappeared. Therefore, numerous areas that were previously routinely announced as 1st-grade areas were revised.

The regions that received the most appeals over the past nine years were as follows: Gyeonggi (169 cases), Gangwon (148 cases), and Gyeongnam (146 cases) (Table 4). However, no appeals were received from Seoul, Daejeon, or Gwangju.

The outcomes of MK test between the number of appeals in relation to the population, area, population density, and 1st-grade area ratio of the ENM for each region are depicted in Fig. 4. The number of appeals did not appear to be related to the population (MK test; $B = 0.260$, $p = 0.148$) or the 1st-grade area ratio of the ENM (MK test; $B = 0.290$, $p = 0.107$). In contrast, the number of appeals had a positive relationship with the regional area (MK test; $B = 0.647$, $p <$

0.001) and a negative relationship with the population density (MK test; $B = 0.290, p = 0.007$).

Discussion

Value of ENM as NEAs

NEAs inform policymakers and practitioners about the value of ecosystems to inform their decision-making (Schröter et al. 2016). Knowing this importance, many NEAs, starting with millennium ecosystem assessment (MEA 2005), were carried out, but these activities were not continued. ENM, Republic of Korea's NEA system, began production in 1998 and was first issued in 2007, and is currently being updated every year. This is not a simple update of data. Not only ENM (nine revisions of guidelines; Table 1), but also SNE, the main component database of ENM, has been revised up to the 5th guideline (NIE 2019). Not

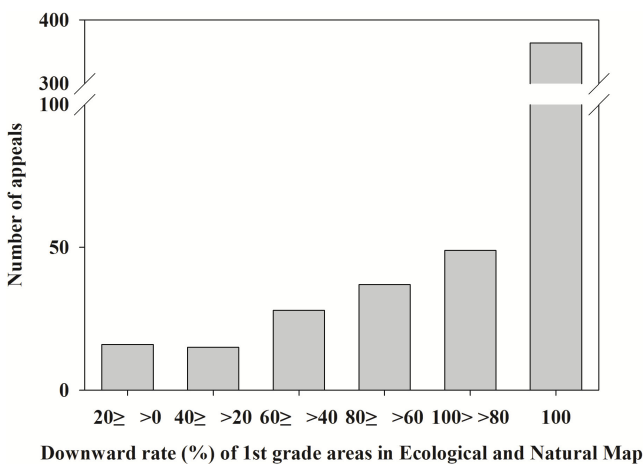


Fig. 3 Downward rate (%) of 1st-grade areas in the Ecological and Natural Map from 2014 to 2022, with respect to appeals.

only the ENM system as NEAs, but also the improvement of the surveys for building the underlying database are revised through meetings where dozens to hundreds of experts from each survey and each field group gather. However, ENM only reflects the academic opinions of experts in the evaluation process, and unlike NEAs in the United Kingdom (UK National Ecosystem Assessment 2011), it has the limitation of not involving stakeholders. Additionally, ENM can be helpful in policy making by discussing the current ecosystem, but it is different from other NEAs that model the future of the ecosystem or deal with the sta-

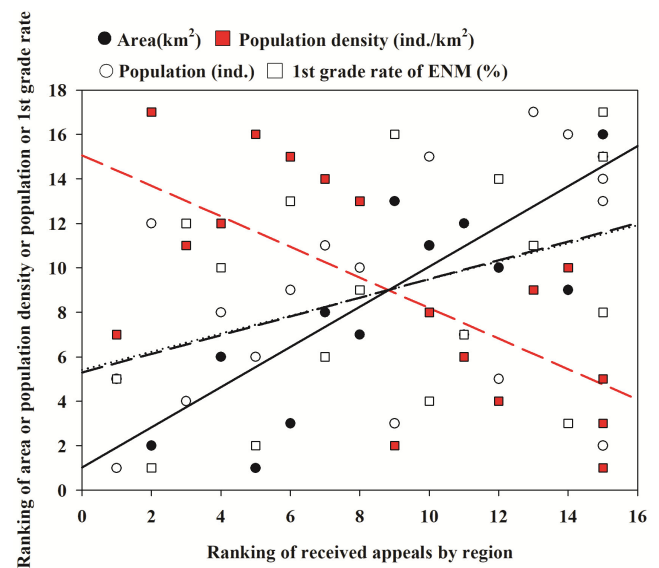


Fig. 4 Kendall's Tau-B test results between appeals and area (km²; dots and line; $B = 0.647, p < 0.001$) or population density (ind./km²; red squares and dash line; $B = 0.290, p = 0.007$) or population (ind.; hollow dots and long dash line; $B = 0.260, p = 0.148$) or 1st-grade area rate (%) of ENM (%; hollow squares and short dash line; $B = 0.290, p = 0.107$) on an ordinal scale. ENM: Ecological and Natural Map.

Table 4 Accumulated appeals of Ecological and Natural Map from 2014 to 2022 by administrative distinct in Republic of Korea

Region	Appeal (case)	Population (ind.)	Area (km ²)	Population density (ind./km ²)	1st-grade rate (%)
Busan	15	3,306,993	770.2	4,293.8	0.4
Chungbuk	32	1,593,931	7,407.0	215.2	3.4
Chungnam	85	2,126,374	8,247.2	257.8	2.0
Daegu	12	2,356,416	883.7	2,666.5	3.1
Daejeon	0	1,445,126	539.5	2,678.6	2.7
Gangwon	148	1,532,617	16,829.7	91.1	19.6
Gwangju	0	1,424,818	501.1	2,843.3	0.4
Gyeongbuk	83	2,588,860	19,034.8	136.0	5.5
Gyeonggi	169	13,618,969	10,196.7	11,380.2	3.9
Gyeongnam	146	3,263,251	10,541.9	309.6	1.7
Incheon	4	2,978,749	1,066.5	2,793.1	0.5
Jeju	1	676,810	1,850.3	365.8	4.9
Jeonbuk	30	1,762,021	8,072.2	218.3	2.5
Jeonnam	41	1,811,554	12,358.9	146.6	1.4
Sejong	2	386,192	464.9	830.7	1.7
Seoul	0	9,414,093	605.2	15,554.3	0.1
Ulsan	13	1,106,015	1,062.3	1,041.1	4.3

tus of ecosystem services (Albert et al. 2016; Jäppinen and Heliölä 2015; Pereira et al. 2013; UK National Ecosystem Assessment 2011). To overcome this, the NIE in Republic of Korea is conducting research to explore ways to utilize ENM for ecosystem services. Ultimately, there is a need for active exchange between NEAs working-level staff from each country to share know-how (Schröter et al. 2016) and become a global ecosystem assessment.

Public thematic map function

Compiling field survey data for mapping is time-consuming, leading to potential discrepancies with the current situation. Despite the advancements in geographic information systems that now enable real-time user interaction, the ENM continues to function as a medium for the unilateral transmission of spatial information to map users in order to fulfill its function as a public data source (NGII 2009). In the early days of the ENM, depending on the year, the application of survey data was delayed by 6–15 years (Jung et al. 2017). Recently, there was a delay of one year before the results of the ecosystem survey were reflected on the map. To recognize and overcome this problem, an appeal system was established from the time the first ENM was produced; however, the system is still maturing. In contrast to other thematic maps, the impact of time delay is bound to be greater because the two elements of change in the natural environment and expert evaluation are reflected simultaneously (Ahn et al. 2015).

Delayed application of the latest status in ENM could cause problems in the establishment of use plans, such as development plans and environmental impact assessments. With the growing utilization and awareness of the ENM, there has been a corresponding increase in appeals (Jung et al. 2017). The number of appeals increased from an average of 23 per year from 2007 to 2013 to an average of 91 per year from 2014 to 2022, when the NIE commenced responsibility (Table 3). The five latest revisions to the ENM Guidelines that have been implemented since the responsibility was transferred to the NIE were supplements to appeals (Table 1); however, the number of appeals continued to increase (Fig. 2). Nevertheless, given that the renewal announcement in 2022 incorporates the results of the 5th SNE at a 1:5,000 scale (more advanced than the existing 1:25,000 scale), it is uncertain whether the decreasing trend in appeals from 2021 to 2022 will persist. Therefore, it is necessary to observe this trend (Ahn et al. 2015; Jung et al. 2017). According to a recently published paper (Kang et al. 2023), the scope of 1st-grade area writing ENM has become more detailed by revising guidelines (2023 compared to 2021). The application of ENM, which is becoming more detailed through continuous improvement, will increase in fields such as development plans, basic data for ecosystem service conservation cooperation funds, environmental conservation value maps, and biotope maps. Therefore, it

may be feasible to reflect on opinions apart from appeals.

Appeal characteristics

The designation of new protected areas every year may lead to problems such as appeals and disputes owing to restrictions on private land (Kim et al. 2017), and the ENM system faces the same problems. In particular, despite the ENM continuing to be publicly announced every year, there are cases in which the designation as a 1st-grade area is not promptly acknowledged. Moreover, there are cases in which the ENM has been modified during the formulation of a development plan. To reduce the problems arising from this, supplementary provisions regarding the ENM were included in the PA issued subsequent to September 3, 2019, following consultation between departments of the ME. However, because development plans sometimes require an annual timeframe, the effectiveness of these provisions is limited.

An appeal system was used for biased purposes to reflect the latest status in the ENM. As an appeal requires consent from the landowner and financial resources, it is difficult to consider an upward appeal to an ENM 1st-grade area where development is restricted. Our findings unequivocally demonstrate this fact, with 91.5% of the received appeals, excluding rejections, being downgraded. Unusually, appeals to downgrade the ENM resulted in the disappearance of the existing 1st-grade areas at a rate of 71.5%. Because the appeal investigation is performed at a 1:5,000 scale, which is considered to simultaneously capture more precise observations and timely changes in biota than the 1:25,000 scale utilized in the existing ENM (Ahn et al. 2015).

Conclusions

Since its announcement in 2007, the ENM has served as a major map showing the current status of the ecosystem in the Republic of Korea. Through improved and developed ecosystem surveys and analytical methods, the ENM has identified new conservation areas. However, the ENM, as a public map, has caused many appeals. Therefore, ENM Guidelines are being revised, focusing on parts related to appeals. Currently, because ENM is a consideration in the feasibility study of various development projects, appeals arise regarding ENM mainly in 1st-grade areas, and in many cases, the map is revised owing to differences in precision and scale. In the Republic of Korea, which has become a developed country, as the number of undeveloped areas in the city gradually decreases, appeals tend to be filed mainly in regions with low population density or a high proportion of 1st-grade areas (relatively undeveloped). As an ENM with improved precision will be provided by 2022, it is necessary to observe the pattern of appeals in the future.

Supplementary Information

Supplementary information accompanies this paper at <https://doi.org/10.5141/jee.23.074>.

Table S1. Appeal types of Ecological and Natural Map from 2014 to 2022.

Abbreviations

NEAs: National ecosystem assessments
 SNE: Survey on natural environment
 ME: Ministry of Environment
 NIER: National Institute of Environmental Research
 NIE: National Institute of Ecology
 ENM: Ecological and Natural Map
 NECA: Natural Environment Conservation Act
 DMAs: Distinct management zones
 PAs: Public announcements
 MK: Mann–Kendall
 NES: Natural Environment Survey

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Authors' contributions

EJK conceptualized the study, did data curation, formal analysis, investigation, validation, writing original draft, reviewing and editing the draft. HL collected resources, did data curation, formal analysis, investigation, and writing original draft. JL did data curation formal analysis, investigation and visualization. WO collected resources, did methodology, project administration, supervision, reviewing and editing the draft. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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