Value Assessment for Inland Wetlands according to Ecological Geographic Distribution

Jung-Hwan Lee·Ran-Young Im†·Gwan-Gyu Lee·Hyun-Chul Park

National Wetlands Center, National Institute of Environmental Research
*Department of Landscape Architecture, Kangwon National University

Abstract
Korea established an inventory of 1,916 sites of inland wetlands during a nationwide investigation from 2000 to 2010. If inland wetlands is included in or near various protected areas designated by the government, it can be selected as a wetland to be managed with priority. This study evaluated the aspect of management of inland wetlands by analyzing the correlation between locations of national protected areas and inland wetlands. As a result, it was shown that a considerable percentage of current inland wetland was located in areas that were designated and managed as protected areas by the government, as they had a high value of natural environment protection (527 sites, 31.61%). When the range was widened to a radius of 1 km for protected areas, 959 sites were included and 57.53% of sites were located in or nearby the protected areas. Among them, 46.79% of sites were distributed up to or within a 1 km radius of waterside areas and rivers; it accounted for 81.33% of wetlands located in protected areas. Therefore, it was found that locations of current inland wetlands were mostly in contact with rivers. The results of overlay analysis were classified into high, medium and low; the correlation of location with inland wetlands was analyzed through the analysis of separation distance of various protected areas. The number of wetlands located in areas of a ‘high’ value of protection was 998 (59.87%); 289 sites (17.34%) were distributed in areas of a ‘low’ value of protection. This implies that these wetlands are located in artificial areas and are more exposed to environmental pressures. Thus, these wetlands could be determined as inland wetlands, which we considered for the establishment of measures to prevent damage.

Key words : conservation, environmental planning, evaluation, protected areas, space decision-making

요약
한국은 2000년부터 2010년까지 전국을 조사하여 총 1,916개소의 내륙습지 인벤토리를 구축한 바 있다. 본 연구는 국가보호지역과 내륙습지와의 입지상관관계를 분석함으로써 내륙습지의 관리가치 측면을 평가하고자 하였다. 그 결과, 내륙습지의 상당수가 자연환경의 보호가치가 높아 국가가 보호지역으로 지정하여 관리하는 지역 내에 입지(527개소, 31.61%)하고 있는 것으로 나타났다. 보호지역 반경 1km까지 범위를 넓혀 보면 959개소로 전체 국가내륙습지의 57.53%에 해당하는 수가 보호지역 내 및 인근에 입지하고 있음을 알 수 있다. 그 중에서도 하천수계 반경 1km 내에 46.79%가 분포하여 보호지역 내 분포하는 습지 중 81.33%를 기록하고 있어서 현재의 내륙습지의 입지는 대부분 하천수계에 접하여 있는 것으로 분석되었다. 각종 보호지역과의 이격거리로 분석하여 종합 분석한 결과를 상, 중, 하로 평주구분하고 내륙습지와의 입지관계를 분석한 결과, 보호가지가 '상'인 지역에 분포한 습지 중 998개소(59.87%)에 해당하였다. 보호구간가 '하'인 지역에 289개소(17.34%)가 분포되어 있는데, 이는 인공화된 지역에 입지한 습지로써 환경압력에 더욱 노출되어 있는 습지임을 의미하므로 훼손방지를 위한 대책수립을 고려해야 할 내륙습지로 의사결정할 수 있다.

핵심용어 : 보전, 환경계획, 평가, 보호지역, 공간의사결정

* To whom correspondence should be addressed.
National Wetlands Center, National Institute of Environmental Research.
E-mail: rany88@korea.kr
1. Introduction

Because wetlands have characteristics of both land and water, they have a higher biodiversity and protection value (Cowardin et al., 1979; Mitsch and Gosselink, 1993; 2000; Cylinder et al., 1995). Thus, they have become the mandatory subjects of policy for national environmental conservation. Since the Ramsar Convention in 1971, Korea has developed policies for wetland conservation. In 1999, Korea established the Wetland Conservation Act for conservation and wise use of wetland biological resources and has implemented policy for wetland conservation. As of 2013, the number of wetland protection areas managed by the government and Ramsar is 32 and 18, respectively (Kim et al., 2013). The area is equivalent to 0.34 % of national territory (Ramsar wetlands 0.18 %) (Mistry of Environment, 2013).

A total of 1,916 national inland wetlands inventories were constructed through a wetlands survey program which was conducted from 2000 to 2010. The Ministry of Environment has made continued efforts to designate ecologically valuable wetlands as ‘Wetland Protected Area’. In order to take care of a large number of inland wetlands, however, the government needs to select target wetlands in advance. If wetlands are situated within or near the protected zones designated and managed by the government such as a national park, they should be chosen as target wetlands first. So far, inland wetlands have been analyzed, focusing on their discovery only based on individual valuation without considering their locational correlation with surroundings. Therefore, this study attempted to quantify the locational correlation of 1,916 national inland wetlands as of 2010 with diverse protected areas and provide basic data for selection of target wetlands which should be managed by the government prior to others. It is expected that the study results would make a contribution to the development of national wetlands conservation policies such as designation of wetland protected areas and wetland ecological corridor.

2. Study Methods

2.1 Study Areas

Inland wetlands distributed throughout Korea, except island areas, were analyzed in this study. As of October 2013, inland wetlands include 1,916 sites nationwide (National Wetlands Center, 2013). If island areas are excluded, this includes 1,667 sites. Gyeonggi Province, including the Seoul metropolitan district and Incheon metropolitan city, contains 192 sites (11.52 % of all wetlands). Gangwon area, Chungcheong area, Yeongnam area and Honam area show the distribution of 170 sites (10.20 %), 278 sites (16.68 %), 658 sites (39.47 %) and 369 sites (22.14 %), respectively (Fig. 1).

In these zones, it will be necessary to design facilities that reflect local features and that interpretation boards and guide
signs are strategically installed so that the zone image is enhanced by location. Further, this enables active management including supplementation, re-installation of existing roads and planning of new roads. Additionally, structures such as roads or guardrails around villages and forest paths may include material changes or changes to the natural color to increase landscape appeal.

2.2 Methods to analyze the correlation between protected areas and inland wetlands

To find out locational relationship between protected areas and inland wetlands, there was simple frequency analysis on current wetlands which are distributed by certain distance from the protected areas. After all, analysis on wetland frequency which is distributed by individual protected area as well as by the entire protected zone makes it possible to figure out the types of protected areas where many wetlands are found. Furthermore, this study analyzed locational correlations between the protected area and inland wetlands after performing correlation analysis with the distance between the individual protected area and wetlands as a spatial variable. The types of protected areas used in this study include the followings (Fig. 2): wildlife sanctuary, wetland protected area, natural park (national, provincial, county), ecological & landscape conservation area and riparian buffer zone (designated and managed by the Ministry of Environment); forest reserve (by Korea Forest Service), protected area of Baekdudaegan (co-designated and managed by the Ministry of Environment and Korea Forest Service); natural monument zone (by Cultural Heritage Administration). Furthermore, this study included the rivers which were highly correlated with the formation of wetlands even though they are not qualified for 'protected area.' For spatial data needed for this analysis were used those provided by diverse services such as environmental geographic information service (EGIS) and forest geographic

![Fig. 2. Current situation of protected areas selected for analysis of correlation of location with inland wetlands.](image)
information service (FGIS). In addition, locational correlations between the protected areas and inland wetlands were analyzed, using ArcGIS 10.1.

2.3 Methods to analyze areas with a high value of ecological geographic protection

In most countries, the zones with high conservation value are designated and managed as ‘protected area.’ Therefore, there is a high possibility that the regions within or near the ‘protected area’ are valuable as well. Hence, if the distance is quantified based on the ‘protected area,’ it would be able to assess the regions with high conservation value. For distance assessment in each protected area was adopted fuzzy theory which can prevent data loss by endowing rating to a ratio scale and control a researcher’s arbitrary judgment (Banai, 1993: You et al., 2006: Graymore et al., 2009). Through the fuzzy theory by the protected area, points (0’ to 10’) were given to a space, and analysis results were all overlapped. After 0’ was given to the areas with relatively low conservation value because of land development, the results of conservation value assessment were classified into Low, Middle and High, using quantile regression (Neter et al., 1990; 1996; Vladimir 1993; You et al., 2006; Graymore et al., 2009). Through this, the fuzzy theory would be adopted to assess the regions with high conservation value. For distance within a 1 km radius of wildlife protection areas, which may have a high possibility that the regions within or near the boundary, the results would be available as basic data in making a decision in a management direction for individual wetlands according to the grade of inland wetlands.

Table 1. Relationships of distance with inland wetlands by each protected area

| Protected Area | Within areas | Cumulative | Cumulative | Cumulative | Cumulative | Cumulative | Cumulative | Cumulative | Cumulative |
|----------------|--------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Ecological landscape conservation areas | 22 (1.32) | 22 (1.32) | 16 (0.96) | 38 (2.28) | 161 (9.66) | 199 (11.94) | 255 (15.30) | 454 (27.23) | 367 (22.02) | 821 (49.25) | 285 (17.10) | 1,106 (66.33) | 561 (33.63) | 1,667 (100) |
| Wildlife protection areas | 49 (2.94) | 49 (2.94) | 47 (2.82) | 93 (5.76) | 1,043 (62.57) | 1,139 (68.33) | 501 (30.05) | 1,640 (98.38) | 27 (1.62) | 1,677 (100) | 0 (0) | 1,677 (100) | 0 (0) | 1,667 (100) |
| National parks | 17 (1.02) | 17 (1.02) | 24 (1.44) | 41 (2.46) | 226 (13.56) | 267 (16.02) | 378 (22.68) | 645 (38.69) | 359 (21.54) | 1,004 (60.23) | 297 (17.82) | 366 (21.96) | 366 (100) | 1,667 (100) |
| Provincial parks | 34 (2.04) | 34 (2.04) | 13 (0.78) | 47 (2.82) | 151 (9.10) | 198 (12.00) | 350 (21.00) | 548 (32.78) | 367 (22.02) | 915 (54.21) | 406 (24.36) | 1,321 (78.70) | 346 (20.76) | 1,667 (100) |
| County parks | 0 (0) | 0 (0) | 3 (0.18) | 3 (0.18) | 204 (12.24) | 207 (12.42) | 294 (17.64) | 501 (30.05) | 354 (21.24) | 855 (51.29) | 200 (12.00) | 1,055 (63.29) | 612 (37.61) | 1,667 (100) |
| Wetland protected areas | 26 (1.56) | 26 (1.56) | 70 (4.20) | 96 (5.76) | 81 (4.96) | 177 (10.62) | 180 (10.80) | 357 (21.42) | 236 (14.16) | 593 (35.57) | 169 (10.14) | 762 (45.71) | 905 (54.29) | 1,667 (100) |
| Rivers and waterside areas | 384 (23.04) | 384 (23.04) | 396 (23.76) | 780 (46.79) | 612 (36.71) | 1,392 (83.50) | 207 (12.42) | 1,599 (95.92) | 24 (1.44) | 1,623 (97.36) | 24 (1.44) | 1,647 (98.80) | 0 (0) | 1,667 (100) |
| Forest protected areas | 0 (0) | 0 (0) | 13 (0.78) | 13 (0.78) | 305 (18.30) | 318 (19.08) | 456 (27.35) | 774 (46.43) | 433 (25.97) | 1,207 (72.41) | 276 (16.56) | 1,483 (88.96) | 184 (11.04) | 1,667 (100) |
| Baekdudae protected areas | 16 (0.96) | 16 (0.96) | 6 (0.36) | 13 (0.78) | 125 (7.50) | 147 (8.82) | 160 (9.60) | 307 (18.42) | 135 (8.10) | 442 (26.51) | 109 (6.54) | 551 (33.05) | 1,116 (66.95) | 1,667 (100) |
| Combining the entire protected areas | 527 (31.61) | 527 (31.61) | 432 (25.91) | 959 (57.53) | 664 (40.83) | 1,623 (97.36) | 44 (2.64) | 1,667 (100) | 0 (0) | 1,667 (100) | 0 (0) | 1,667 (100) | 0 (0) | 1,667 (100) |

3. Results and Discussion

3.1 Relationship of location between protected areas and inland wetlands

We found that 1,667 sites of Korea’s inland wetlands (excluding island areas such as Jeju island) were located within a 20 km radius of national protected areas (Table 1). Wetlands located within the protected areas accounted for 31.61 % (527 sites) of entire inland wetlands. If a standard radius of 1 km of boundary of protected area was applied, 57.53 % (959 sites) of wetlands were located within that boundary. This demonstrates that more than half of inland wetlands (959 sites) are located adjacent to the protected areas.

In particular, it was found that approximately 83.50 % of wetlands were located within 10 km of river boundaries. As a result of our analysis of rivers and riverside areas, we found that most of inland wetlands were highly correlated with location of rivers. In fact, approximately half of inland wetlands (780 sites, 46.79 %) were located within a 1 km radius of rivers and waterside areas.

In the case of wildlife protection areas, which may have the second–highest correlation of location except river areas, it was found that all inland wetlands were located within a 30 km boundary. If the standard of 20 km was applied, 93.38 % (1,640 sites) of wetlands were located within the boundary. Conversely, only 93 wetland sites were located within a 1 km radius of wildlife protection areas, which...
accounted for 5.76%. Thus, 62.57% (1,043 sites) of wetlands were concentrated within the radius of 1 to 10 km. This phenomenon may be caused by characteristics such as most wildlife protection areas being distributed in the forest (Lee, 2011). When analyzing the relationship between the location distance of national class rivers and inland wetlands and the location distance of wildlife protection area and inland wetlands, a coefficient of determination of 0.004 (p=0.879, sig=0.005) was determined (Table 2). Thus, the correlation of location between rivers and wildlife protection areas could be understood as largely independent.

When examining forest-protected areas for genetic resources, we found almost no wetland habitat located within forest-protected areas; most sites (99.22%, 1,654 sites) were distributed within a 1 km radius. Forest-protected areas had considerable separation distance compared with wetlands. Considering the relationship with Baekdudaegan protected areas, only 0.96% (16 sites) were located in protected areas and only 1.32% (22 sites) were located within 1 km; many (98.68%) were beyond the 1 km radius. The number of current inland wetlands types was 23 (Mistry of Environment, 2011). As it was shown that most inland wetlands were concentrated and discovered as river types, it is necessary to enhance the investigation, discovery and conservation policy of wetlands located within mountains in future studies.

3.2 Analysis of the correlation between location of inland wetlands and protected areas

The relationship between each protected area and inland wetlands were defined as variables and correlation analysis was performed (Table 2). The variable of ‘location distance between areas combining the entire protected areas and inland wetlands (X10)’ and the variable of ‘location distance between rivers area and inland wetlands (X7)’ had a coefficient of determination of 0.416 (p=0.416, sig=0.01). This value represents the highest correlation coefficient. As discussed in the analysis of simple frequency, the location correlation between rivers and inland wetlands was very high. The correlation of variables (except X7 with X10)

Table 2. Coefficient matrix of location of wetlands between protected areas

|     | X1  | X2  | X3   | X4   | X5   | X6   | X7   | X8   | X9   | X10  |
|-----|-----|-----|------|------|------|------|------|------|------|------|
| X1  | 1.00|     |      |      |      |      |      |      |      |      |
| X2  | .010( .667) | 1.00|      |      |      |      |      |      |      |      |
| X3  | -.195** (.000) | .058* (.017) | 1.00|      |      |      |      |      |      |      |
| X4  | -.030 (.219) | .179** (.000) | .017 (.485) | 1.00|      |      |      |      |      |      |
| X5  | .297** (.000) | .060* (.014) | -.252** (.000) | .159** (.000) | 1.00|      |      |      |      |      |
| X6  | .518** (.000) | .022 (.362) | -.192** (.000) | .136** (.523) | .333** (.000) | 1.00|      |      |      |      |
| X7  | -.104** (.000) | .004 (.879) | -.027 (.275) | .016 (.578) | .093** (.000) | .197** (.000) | 1.00|      |      |      |
| X8  | .024 (.325) | .039 (.112) | .131** (.000) | .014 (.000) | .234** (.000) | -.126** (.000) | -.094** (.000) | 1.00|      |      |
| X9  | -.284** (.000) | -.074** (.002) | .233** (.000) | -.090** (.000) | .073** (.003) | -.489** (.000) | .084** (.001) | .258** (.000) | 1.00|      |
| X10 | .039 (.111) | .253** (.264) | .027 (.071) | .044 (.000) | .200** (.000) | .105** (.000) | .416** (.000) | .070** (.004) | .176** (.000) | 1.00|      |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Note.
X1 = Location distance between Ecological landscape conservation areas and inland wetlands
X2 = Location distance between Wildlife protection areas and inland wetlands
X3 = Location distance between National parks and inland wetlands
X4 = Location distance between Provincial parks and inland wetlands
X5 = Location distance between County parks and inland wetlands
X6 = Location distance between Wetland protected areas and inland wetlands
X7 = Location distance between Rivers(andsides areas) and inland wetlands
X8 = Location distance between Forest protected areas and inland wetlands
X9 = Location distance between Baekdudaegan protected areas and inland wetlands
X10 = Location distance between areas combining the entire protected areas and inland wetlands
showed a very low correlation (0.200); in terms of location correlations, they were independent of each other. The variable X2 (location distance between wildlife protection areas and inland wetlands), except with X7, showed a low correlation of 0.253.

### 3.3 Results of analysis of areas with high values of ecological and geographical protection

After the distance relationship of the main protected areas was analyzed (Fig. 3), the results were overlapped and areas with high values of ecological and geographical protection were derived (Fig. 4). Areas with a high class of protection value accounted for 33.86% and were located in Baekdudaegan area, Jiri mountain areas, and national parks area. In the case of Gangwon, areas with high class of protection values accounted for 39.37% of the entire area of Gangwon, which was relatively higher than other areas. In the case of the Gyeonggi/Seoul metropolitan areas, areas with high and low classes of protection value accounted for 27.29% and 43.43%, respectively (Table 3). The proportion of areas with a low class of protection value was relatively higher than that of other areas.

![Diagram](a) Wildlife protection areas  (b) Natural monuments protection areas  (c) Baekdudaegan protection areas  (d) Natural parks

![Diagram](e) Forest protection areas  (f) Ecological landscape conservation areas  (g) Wetland protection areas  (h) Rivers and waterside areas

**Fig. 3.** Results of analysis of protection values based on distance in each protection area. (Legend : 0  10).

| Protection value | Nationwide area | Gyeonggi/Seoul metropolitan area | Gangwon area | Chungcheong area | Youngnam area | Honam area |
|------------------|-----------------|---------------------------------|--------------|-----------------|---------------|------------|
| High             | 32,823.31(33.86)| 3,203.58(27.29)                 | 6,625.61(39.37) | 5,783.76(34.62) | 10,329.56(32.21) | 6,880.80(35.10) |
| Middle           | 31,894.77(32.90)| 3,436.74(29.28)                 | 5,439.95(32.32) | 5,359.31(32.09) | 10,871.64(33.89) | 6,787.13(34.63) |
| Low              | 32,229.18(33.24)| 3,098.23(43.43)                 | 4,764.55(28.31) | 5,560.29(33.29) | 10,872.33(33.90) | 5,933.78(30.27) |
| Total            | 96,947.26       | 11,738.55                       | 16,830.11     | 16,703.36       | 32,073.53      | 19,601.71   |

*Table 3.** Comparison of distribution areas of national inland wetlands by classes of protection value in each area (unit : km², %)
3.4 Correlation between location of areas with a high value of ecological and geographical protection and wetlands

Wetlands located in the areas with a high value of ecological and geographical protection accounted for 59.87 % of entire wetland areas (998 sites). Among them, 380 and 289 sites were located in areas with middle (22.80 %) and low (17.34 %) classes of protection value, respectively (Table 4, Fig. 5). This implies that inland wetlands are more distributed in the areas with high values of protection, which should be referenced to establish preferential protection policies for inland wetlands. A strategy for the investigation of adjacent areas of priority, with consideration of the distance relationship of protected areas, is needed for future discovery of wetlands that need to be protected and maintained.

Wetlands located in areas with a low class of protection value tend to be relatively more exposed to development pressures (Fig. 5). However, inland wetlands with high values of protection are still easily exposed to surrounding environmental pressures. Thus, specific management techniques and policies are needed for protection of wetlands. For wetlands exposed to higher levels of environmental pressure, special management for endangered wetlands would be needed; if damage by environmental pressures cannot be avoided, composition of alternative wetlands may be considered. Improved conservation policy is needed for the effective management of wetlands within the wetland management system of this study.

Fig. 4. Results of analysis (a) on areas with high value of ecological and geographical protection and (b) classification.

Fig. 5. Classification of protection value and distribution of inland wetlands.
(Legend: High  Middle  Low  Inland wetlands)
Table 4. Current situation of distribution of inland wetlands in each class of value of ecological and geographical protection

| Distribution of inland wetlands | Class of value of ecological and geographical protection |
|--------------------------------|--------------------------------------------------------|
| Number of sites (%)            | Total | High  | Middle | Low   |
| 1,667 (100)                   | 998   | 380   | 289    |

4. Conclusions

The purpose of this study was to evaluate the aspect of management value of inland wetlands by analyzing the correlation between locations of protected areas and inland wetlands with subjects of 1,667 sites of national inland wetlands, excluding island areas. Areas with a high value of ecological and geographical protection were derived using fuzzy analysis and quantile regression on distance relationships with each protected area. The following conclusions and implications were derived from analyzing the correlation of location with inland wetlands.

First, it was shown that all the inland wetlands were located within 20 km of areas combining the entire protected areas. In particular, it was found that approximately 95.92% of wetlands were located within 20 km of river boundaries. In addition, it was found that only a small portion of wetland was distributed in mountain areas, such as forest protected areas or Baekdudaegan protected areas. These results suggest that future wetland delineations should incorporate surveys of mountain habitat.

Second, it was shown that areas with high, middle, and low classes of protection value accounted for 33.86%, 32.90% and 33.24%, respectively. In addition, it was shown that Baekdudaegan areas, National parks areas had high values of protection. The Gangwon area had a relatively high value of protection (39.39%) compared with those in other areas. In the case of the Gyeonggi/Seoul metropolitan areas, it was shown that areas with a low class of protection value were more distributed compared with other regions.

Third, wetlands located in areas with a high class of ecological and geographical protection accounted for 59.87% of the entire wetland area, which was equivalent to 998 sites. In contrast, wetlands located in areas with a low class of protection value were found to be relatively more exposed to development pressure. These results imply the need for the establishment of management plans to protect wetland systems.

Future research on wetland distribution in areas with a high class of protection value that have a high class of wetlands, is needed to identify wetlands that should be managed with priority by the government.

Acknowledgements

This study is supported by Korea Environmental Industry & Technology Institute (KEITI) as "Eco Innovation Project (No. 416–111–013)" and National Wetlands Center (NWC) in Republic of Korea.

References

Banai, R (1993). Fuzziness in geographical information systems: contributions from the analytic hierarchy process, *International J. of Geographical Information Systems*, 7(4), pp. 315–329.

Cowardin, LM, Carter, V, Golet, FC and LaRoe, ET (1979). Classification of wetlands and deepwater habitats of the United States, *US Fish and Wildlife Service FWS/OBS*, 79(31), pp. 131.

Cylinder, PD, Bogdan, KM, Davis, EM and Herson, AI (1995). *Wetlands Regulation: A Complete Guide to Federal and California Programs*, Solano Press Books, California, USA.

Graymore MLM, Wallis, AM and Richards, AJ (2009). An index of regional sustainability: A GIS-based multiple criteria analysis decision support system for progressing sustainability, *Ecological Complexity*, 6(4), pp. 453–462.

Kim, TS, Jeong, JW, Moon, SG, Yang, HS and Yang, BG (2013). Introduction of national mid- term fundamental plan for wetlands conservation and management, *J. of Wetlands Research*, 15(4), pp. 519–527. [Korean Literature]

Lee, GG (2011). Distributional characteristics and improvements for wildlife Protection Areas in South Korea, *J. of Environment Impact Assessment*, 20(5), pp. 685–695. [Korean Literature]

Mistry of Environment (2011). *The 3rd Inland Wetlands Investigation Guidelines Research*, Sejong, Korea. [Korean Literature]

Mistry of Environment (2013). *The Current Situation of registration of wetland conservation area and ramsar wetland* (2012.12), Sejong, Korea. [Korean Literature]

Mitsch, WJ and Gosselink, JG (1993). *Wetlands, 2nd Edition*, Wiley, New York, USA.

Mitsch, WJ and Gosselink, JG (2000). The value of wetlands: importance of scale and landscape setting, *Ecological Economics*, 35(1), pp. 25–33.

National Wetlands Center (2013). *The 1st Inland Wetlands Monitoring Guidelines*, Changnyeong, Korea. [Korean Literature]
Neter, J, Kutner, M, Wasserman, W and Nachtsheim, C (1996). *Applied Linear Statistical Models 4th Edition*, Irwin, Chicago, USA.
Neter, J, Wasserman, W and Kutner, MH (1990). *Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs*, Irwin, Homewood, USA.
Vladimir, S, Wangb, W and Härdle, WK (2013). Local quantile regression, *J. of Statistical Planning and Inference*, 143(7), pp. 1109–1129.
You, JH, Jung, SG, Choi, WY and Lee, WS (2006). Rank Decision of Ecological Environment Assessment Field Introducing Fuzzy Integral, *J. of the Korean Institute of Landscape Architecture*, 34(5), pp. 39–51. [Korean Literature]