**Supplementary Materials**

**Spatial Patterns of Sandy Beaches in China and Risk Analysis of Human Infrastructure Squeeze Based on Multi-Source Data and Ensemble Learning**

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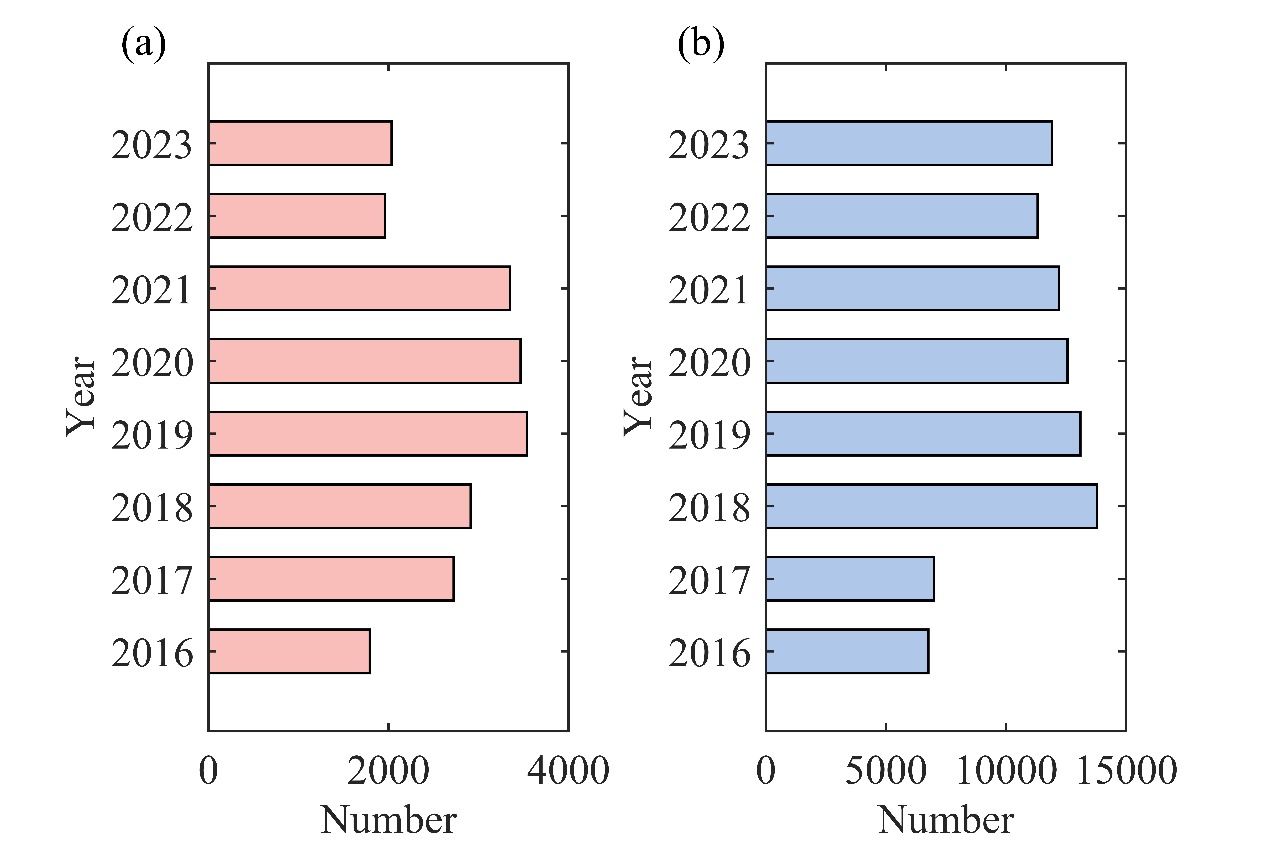
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**This file includes:**

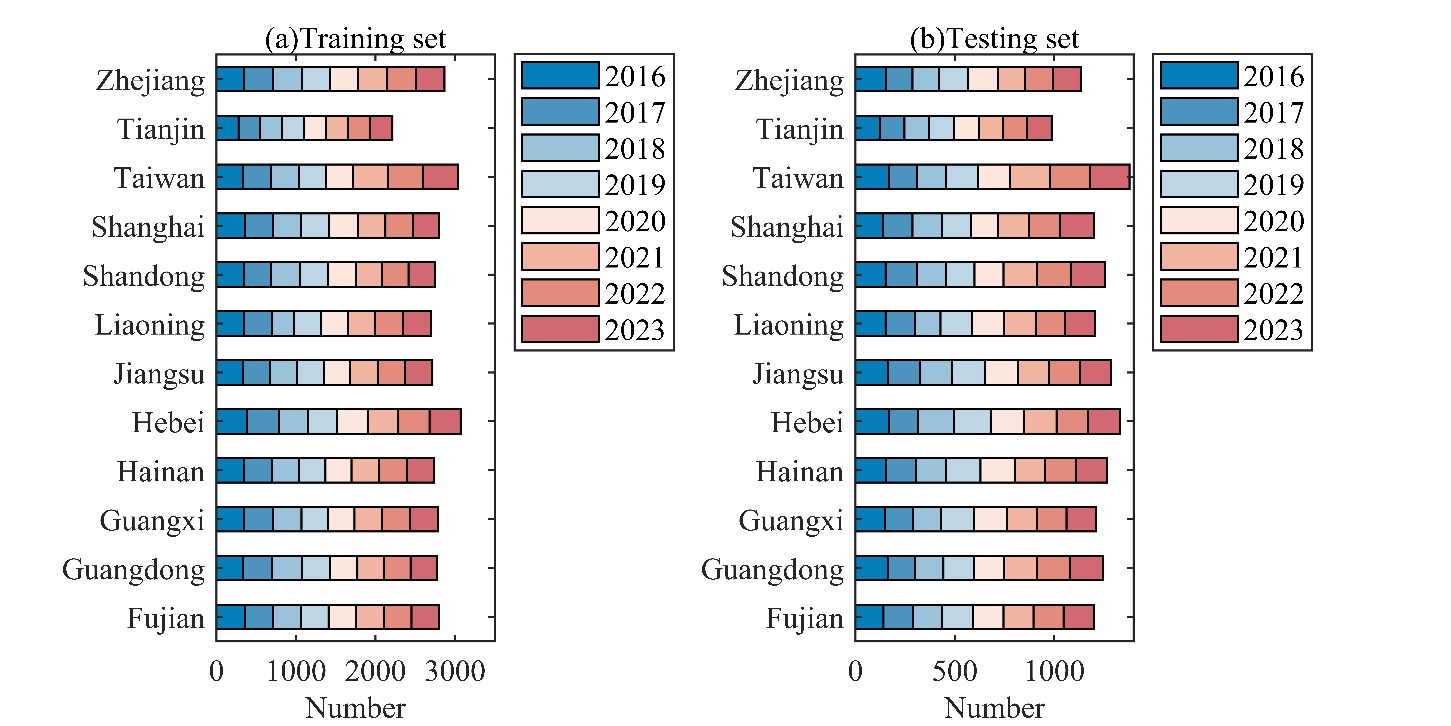
Figs. S1 to S6

Table S1

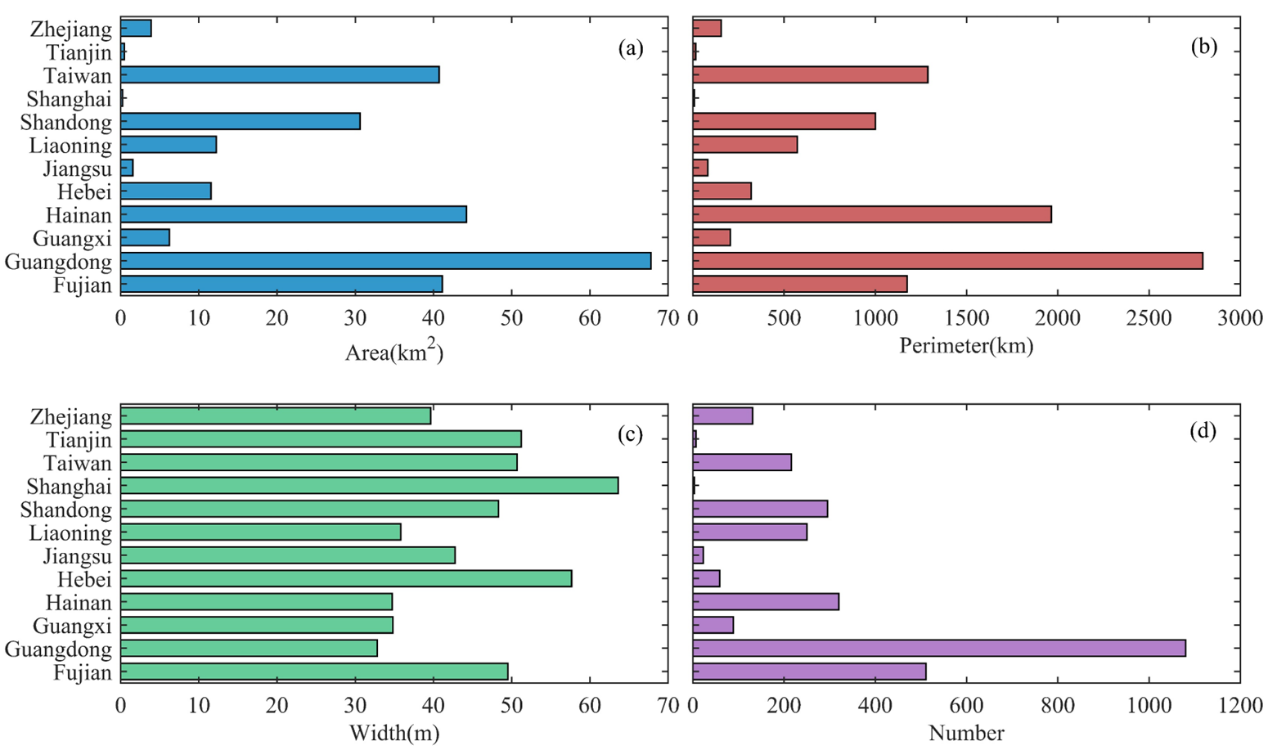
**Supplementary Figures**



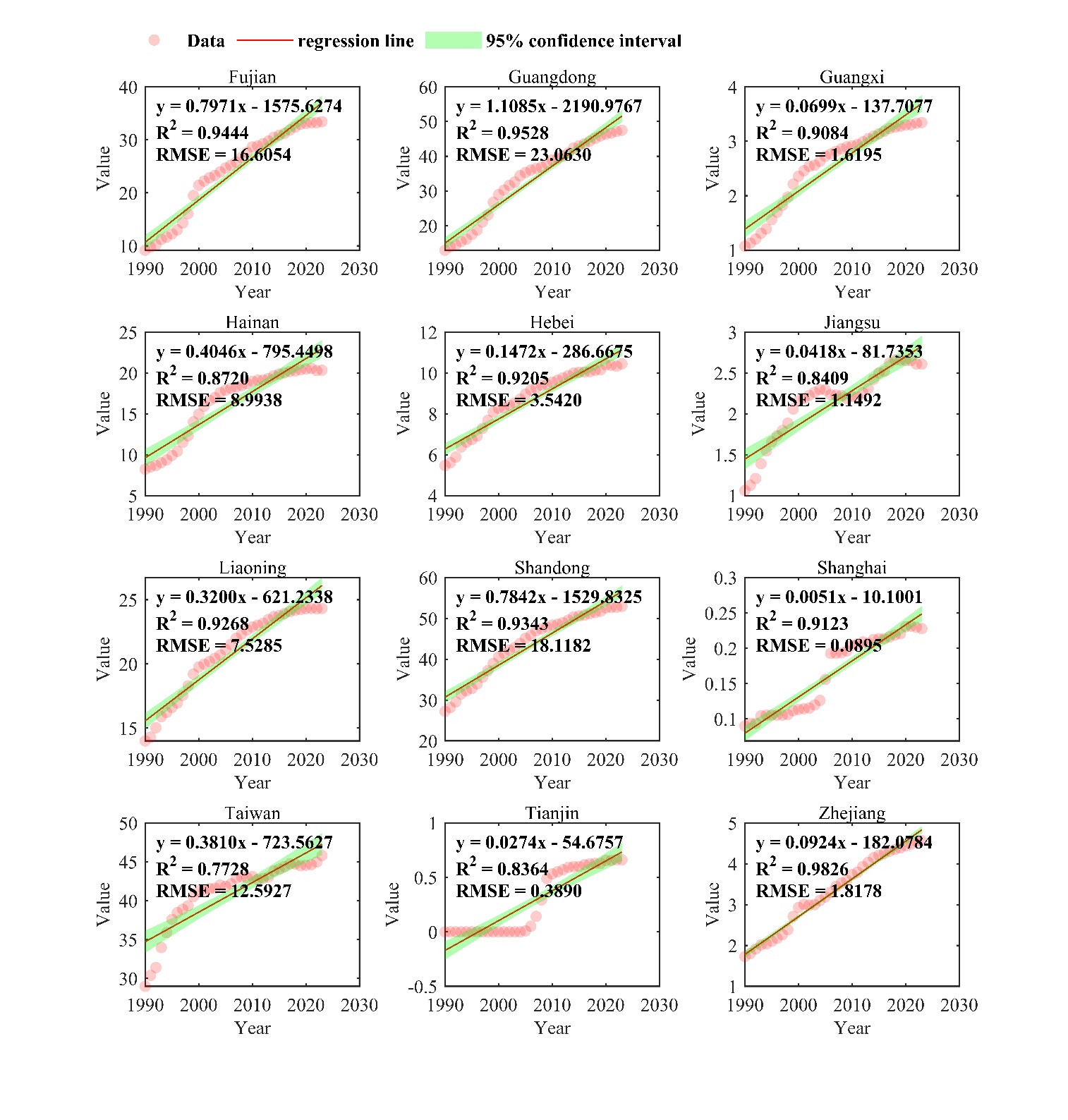
**Figure S1.** Image Count from 2016 to 2023: (a) Image Count of Sentinel-1, (b) Image Count of Sentinel-2.



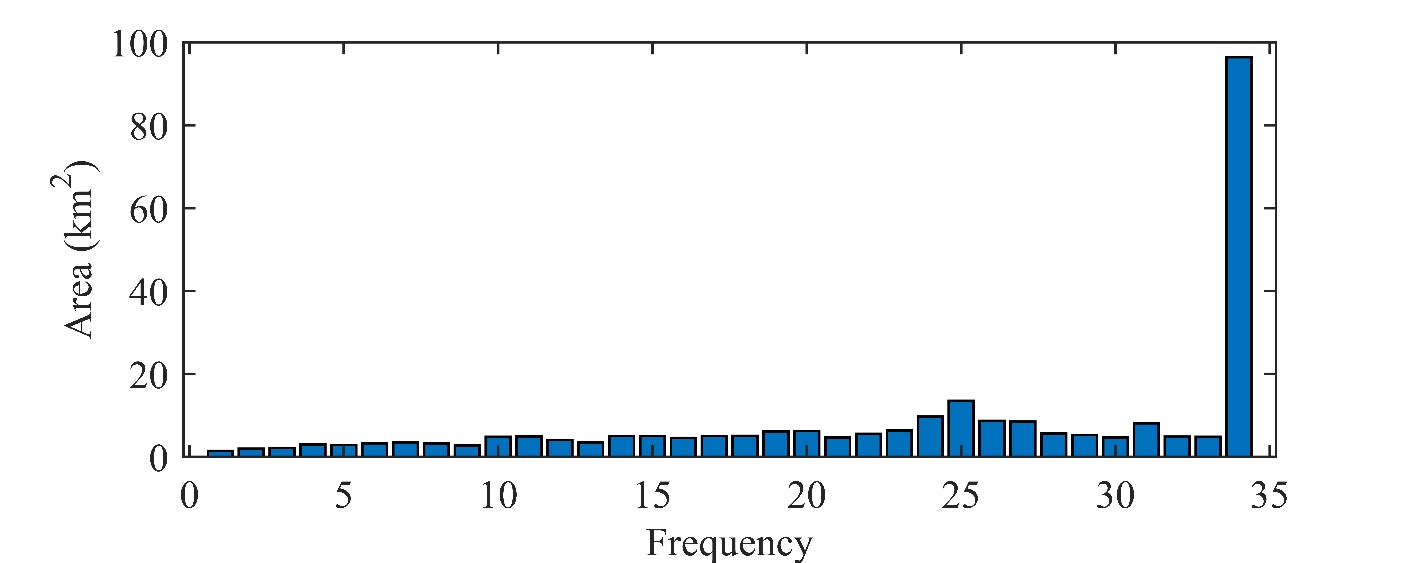
**Figure S2.** Training and testing set distribution: (a) Training set distribution, (b) Testing set distribution.



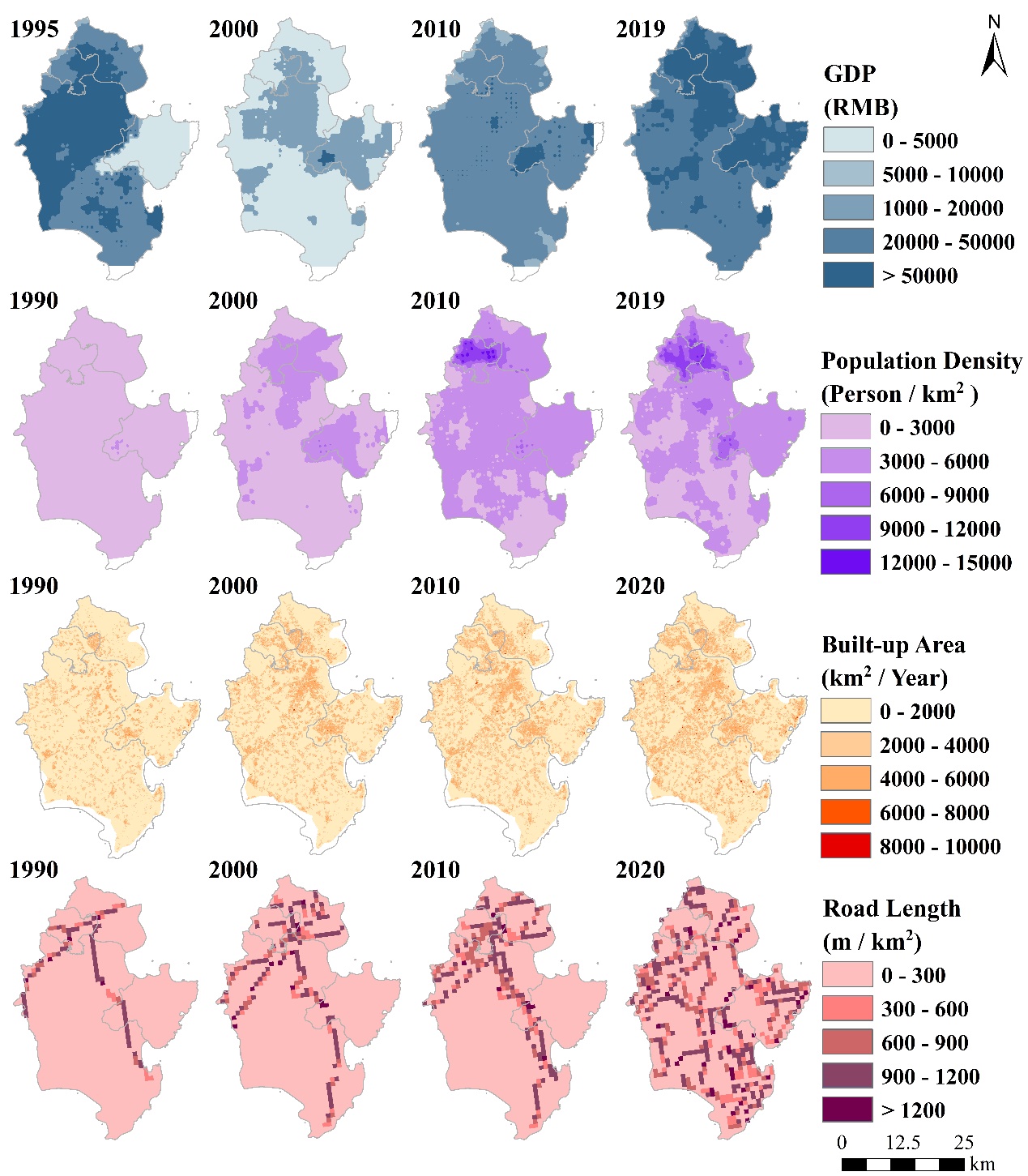
**Figure S3.** Characteristics of the sandy beach: (a) sandy beach area, (b) sandy beach perimeter, (c) sandy beach width, (d) sandy beach number.



**Figure S4.** Interannual changes in the area at risk of human infrastructure squeeze across different regions.



**Figure S5.** Frequency of human infrastructure squeeze risk.



**Figure S6.** Changes in indicators such as GDP, population density, built-up area, and road length.

**Supplementary Table**

Table S1. Accuracy of sandy beach classification in different regions.

| Region | Year | OA | Kappa Coefficient | Region | Year | OA | Kappa Coefficient |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Liaoning | 2016 | 0.94 | 0.92 | Hebei | 2016 | 0.96 | 0.95 |
|  | 2017 | 0.95 | 0.94 |  | 2017 | 0.97 | 0.96 |
|  | 2018 | 0.94 | 0.92 |  | 2018 | 0.98 | 0.98 |
|  | 2019 | 0.94 | 0.93 |  | 2019 | 0.97 | 0.96 |
|  | 2020 | 0.90 | 0.88 |  | 2020 | 0.94 | 0.93 |
|  | 2021 | 0.95 | 0.94 |  | 2021 | 0.93 | 0.91 |
|  | 2022 | 0.95 | 0.94 |  | 2022 | 0.95 | 0.94 |
|  | 2023 | 0.95 | 0.93 |  | 2023 | 0.96 | 0.94 |
| Tianjin | 2016 | 0.89 | 0.86 | Shandong | 2016 | 0.98 | 0.98 |
|  | 2017 | 0.98 | 0.98 |  | 2017 | 0.99 | 0.98 |
|  | 2018 | 0.95 | 0.94 |  | 2018 | 0.97 | 0.96 |
|  | 2019 | 0.94 | 0.92 |  | 2019 | 0.96 | 0.95 |
|  | 2020 | 0.94 | 0.93 |  | 2020 | 0.95 | 0.93 |
|  | 2021 | 0.98 | 0.97 |  | 2021 | 0.96 | 0.95 |
|  | 2022 | 0.98 | 0.97 |  | 2022 | 0.96 | 0.96 |
|  | 2023 | 0.94 | 0.92 |  | 2023 | 0.95 | 0.93 |
| Jiangsu | 2016 | 0.95 | 0.93 | Shanghai | 2016 | 0.93 | 0.91 |
|  | 2017 | 0.97 | 0.96 |  | 2017 | 0.95 | 0.93 |
|  | 2018 | 0.96 | 0.95 |  | 2018 | 0.93 | 0.92 |
|  | 2019 | 0.93 | 0.91 |  | 2019 | 0.93 | 0.91 |
|  | 2020 | 0.93 | 0.91 |  | 2020 | 0.93 | 0.92 |
|  | 2021 | 0.95 | 0.94 |  | 2021 | 0.94 | 0.92 |
|  | 2022 | 0.96 | 0.95 |  | 2022 | 0.94 | 0.92 |
|  | 2023 | 0.96 | 0.95 |  | 2023 | 0.96 | 0.96 |
| Zhejiang | 2016 | 0.97 | 0.96 | Fujian | 2016 | 0.95 | 0.94 |
|  | 2017 | 0.98 | 0.97 |  | 2017 | 0.98 | 0.97 |
|  | 2018 | 0.98 | 0.97 |  | 2018 | 0.96 | 0.95 |
|  | 2019 | 0.96 | 0.95 |  | 2019 | 0.93 | 0.91 |
|  | 2020 | 0.98 | 0.97 |  | 2020 | 0.95 | 0.94 |
|  | 2021 | 0.94 | 0.93 |  | 2021 | 0.95 | 0.94 |
|  | 2022 | 0.96 | 0.95 |  | 2022 | 0.96 | 0.95 |
|  | 2023 | 0.94 | 0.93 |  | 2023 | 0.94 | 0.93 |
| Taiwan | 2016 | 0.94 | 0.93 | Guangdong | 2016 | 0.94 | 0.93 |
|  | 2017 | 0.93 | 0.91 |  | 2017 | 0.96 | 0.95 |
|  | 2018 | 0.93 | 0.92 |  | 2018 | 0.98 | 0.97 |
|  | 2019 | 0.93 | 0.91 |  | 2019 | 0.98 | 0.98 |
|  | 2020 | 0.93 | 0.91 |  | 2020 | 0.96 | 0.95 |
|  | 2021 | 0.91 | 0.89 |  | 2021 | 0.97 | 0.96 |
|  | 2022 | 0.93 | 0.91 |  | 2022 | 0.95 | 0.93 |
|  | 2023 | 0.94 | 0.9 |  | 2023 | 0.97 | 0.96 |
| Guangxi | 2016 | 0.93 | 0.92 | Hainan | 2016 | 0.97 | 0.96 |
|  | 2017 | 0.95 | 0.94 |  | 2017 | 0.94 | 0.93 |
|  | 2018 | 0.93 | 0.91 |  | 2018 | 0.98 | 0.98 |
|  | 2019 | 0.96 | 0.95 |  | 2019 | 0.94 | 0.93 |
|  | 2020 | 0.93 | 0.92 |  | 2020 | 0.92 | 0.91 |
|  | 2021 | 0.95 | 0.93 |  | 2021 | 0.93 | 0.92 |
|  | 2022 | 0.95 | 0.93 |  | 2022 | 0.96 | 0.95 |
|  | 2023 | 0.95 | 0.93 |  | 2023 | 0.92 | 0.90 |