**Supplementary materials**

**Attention Convolutional Neural Networks and Long Short-Term Memory Model: Unveiling Spatiotemporal Dynamics of Ecological Indicators**

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**Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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图示

描述已自动生成

Figure S1. FVC data of Ili River mining area from (a) 2005, (b) 2007, (c) 2009, (d) 2011, (e) 2013, (f) 2015, (g) 2017, (h) 2019, (l) 2021 and (j) 2023.

山边的公路

描述已自动生成

Figure S2. Aerial photo of Ili River Valley mining area at restoration stage.

图示, 地图

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Figure S3. RSEI data of Ili River mining area from (a) 2005, (b) 2007, (c) 2009, (d) 2011, (e) 2013, (f) 2015, (g) 2017, (h) 2019, (l) 2021 and (j) 2023.

图示

描述已自动生成

Figure S4. LULC data of Ili River mining area from (a) 2005, (b) 2007, (c) 2009, (d) 2011, (e) 2013, (f) 2015, (g) 2017, (h) 2019, (l) 2021 and (j) 2023.

Table S1. FVC values of the Nanzhao Special Zone, the north bank of the Ili River and the South bank of the Ili River for 2004-2023, and the FVC values predicted by different machine learning models for 2024.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Years | FVC | | | |
| Nanzhao Special Zone | North bank of Ili River | South bank of Ili River | Average |
| 2024 Atttention CNN-LSTM | 0.551 | 0.610 | 0.579 | 0.580 |
| 2024 CNN-LSTM | 0.504 | 0.530 | 0.510 | 0.515 |
| 2024 LSTM | 0.497 | 0.528 | 0.493 | 0.506 |
| 2024 CNN | 0.507 | 0.556 | 0.531 | 0.531 |
| 2023 | 0.602 | 0.582 | 0.680 | 0.617 |
| 2022 | 0.548 | 0.536 | 0.653 | 0.585 |
| 2021 | 0.548 | 0.536 | 0.653 | 0.575 |
| 2020 | 0.617 | 0.563 | 0.691 | 0.519 |
| 2019 | 0.643 | 0.615 | 0.726 | 0.657 |
| 2018 | 0.604 | 0.573 | 0.683 | 0.616 |
| 2017 | 0.621 | 0.627 | 0.733 | 0.654 |
| 2016 | 0.663 | 0.643 | 0.737 | 0.677 |
| 2015 | 0.625 | 0.621 | 0.703 | 0.646 |
| 2014 | 0.567 | 0.538 | 0.599 | 0.564 |
| 2013 | 0.576 | 0.583 | 0.643 | 0.598 |
| 2012 | 0.557 | 0.537 | 0.621 | 0.568 |
| 2011 | 0.584 | 0.567 | 0.651 | 0.597 |
| 2010 | 0.582 | 0.550 | 0.656 | 0.592 |
| 2009 | 0.572 | 0.570 | 0.648 | 0.594 |
| 2008 | 0.515 | 0.491 | 0.591 | 0.528 |
| 2007 | 0.571 | 0.581 | 0.651 | 0.598 |
| 2006 | 0.507 | 0.500 | 0.606 | 0.534 |
| 2005 | 0.540 | 0.547 | 0.539 | 0.572 |
| 2004 | 0.578 | 0.581 | 0.635 | 0.596 |

Table S2. RSEI values of the Nanzhao Special Zone, the north bank of the Ili River and the South bank of the Ili River for 2004-2023, and the RSEI values predicted by different machine learning models for 2024.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Years | RSEI | | | |
| Nanzhao Special Zone | North bank of Ili River | South bank of Ili River | Average |
| 2024 Atttention CNN-LSTM | 0.562 | 0.506 | 0.621 | 0.563 |
| 2024 CNN-LSTM | 0.590 | 0.514 | 0.617 | 0.574 |
| 2024 LSTM | 0.543 | 0.492 | 0.595 | 0.543 |
| 2024 CNN | 0.566 | 0.507 | 0.621 | 0.565 |
| 2023 | 0.513 | 0.557 | 0.526 | 0.492 |
| 2022 | 0.538 | 0.473 | 0.529 | 0.510 |
| 2021 | 0.473 | 0.441 | 0.531 | 0.478 |
| 2020 | 0.556 | 0.451 | 0.567 | 0.519 |
| 2019 | 0.579 | 0.489 | 0.589 | 0.548 |
| 2018 | 0.548 | 0.493 | 0.579 | 0.537 |
| 2017 | 0.530 | 0.467 | 0.559 | 0.515 |
| 2016 | 0.560 | 0.515 | 0.583 | 0.550 |
| 2015 | 0.592 | 0.456 | 0.524 | 0.518 |
| 2014 | 0.494 | 0.411 | 0.458 | 0.443 |
| 2013 | 0.491 | 0.465 | 0.505 | 0.485 |
| 2012 | 0.503 | 0.443 | 0.491 | 0.475 |
| 2011 | 0.547 | 0.470 | 0.530 | 0.513 |
| 2010 | 0.553 | 475 | 0.549 | 0.522 |
| 2009 | 0.535 | 0.456 | 0.510 | 0.497 |
| 2008 | 0.510 | 0.451 | 0.516 | 0.489 |
| 2007 | 0.523 | 0.476 | 0.521 | 0.505 |
| 2006 | 0.485 | 0.441 | 0.528 | 0.481 |
| 2005 | 0.476 | 0.428 | 0.465 | 0.455 |
| 2004 | 0.493 | 0.459 | 0.515 | 0.487 |