Research and implementation of a universal workflow model to evaluate the soil fertility based on OGC Web Service

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ABSTRACT

A method based on workflow technology and Open Geospatial Consortium (OGC) specification is proposed to establish a universal workflow conceptual model in the network environment. In this paper, the soil fertility evaluation conceptual model was developed as an evaluation method of soil fertility by analyzing the GIS-based fertility evaluation method and extracting the dynamic variable to verify the feasibility model. This validation process involves determining the instantiation of the conceptual model. The proposed conceptual model achieved the following goals. All data acquisition and processing functions were packaged into an OGC-compliant service model; these service models were organized into a processing chain in a certain order on the workflow platform by Petri-Net; the fertility evaluation was realized on the workflow platform by calling the processing chain. Results showed that processing functions and data can be shared in the network environment, and the network workflow model can be realized by the workflow technology. The successful implementation of fertility evaluation proved the feasibility of the network-based universal workflow conceptual model. In addition, the flexibility of our modeling method is demonstrated by reconstructing the workflow model.

1. Introduction

Soil quality shows significant effects on the crop yields, and the soil quality evaluation method should be further developed with the new computer technology. Fertility evaluation data processing is complex, and the fertility evaluation work must be conducted repeatedly because of the frequent data updates, which increases the workload. In addition, these works are difficult to be popularized because the professional software and technician are needed. Therefore, it is necessary to find a way to evaluate the soil fertility without relying on local software. With the recent development of the web service concept, it is required that the data and functionality should be shared in a network environment.

The Open Geospatial Consortium (OGC) is a universal standard organization that focuses on research into geospatial data sharing and interoperability (Chen et al. 2012). OGC Web Services (OWS) standards facilitate the delivery, analysis, and visualization of geospatial data in the network environment. For example, a map can be delivered over the Web through the Web Map Service (WMS), geographic features and coverage data can be requested and queried from the Web Feature Service (WFS), and Web Coverage Service (WCS), respectively (Han et al. 2012). In addition, the OGC Web Processing Service (WPS) specification defines a standardized interface to publish and perform geospatial processes over the Web (Chen et al. 2010a). Hence, we can deploy geospatial data and process into OGC Web Services that include data sharing and interoperability. Goodall, Robinson, and Castronova (2011) introduced WPS as a network interface standard for soil water network analysis and expanded the analysis model of water resources. Giuliani, Ray, and Lehmann (2011) calculated a normalized difference vegetation index by mediating different geospatial and grid software packages with PyWPS under the web environment. The data and functionality of network applications have already been reported in a lot of previous studies. Although these studies proposed some methods that do not depend on the local software, a relatively complete solution has not been realized yet. Therefore, it is necessary to establish functional integration implementation framework through geographic information sharing service system, aiming at solving the specific and complex problems in the network environment.

Workflow technology automates the processing of data tasks according to predefined processing rules, improving efficiency. Workflow and Web service technology can be combined to achieve workflow processing in the network environment. In this study, a fertility evaluation conceptual model was built based on the OGC standards and workflow
technology to identify a universal framework for soil fertility evaluation. The evaluation process involves integrating data and functionality into a network environment to establish a universal network-based workflow model. Taking the Honghuatao Town city of Yidu as an example, the fertility evaluation is automatically achieved based on the network through the sharing of data and functions. The advantage of the method is that we can call the online fertility evaluation model service to realize the automated fertility evaluation without knowing the specific data processing process. Therefore, the method can improve the efficiency of data processing without relying on local software. In addition, this article also provides the ideas for the relevant researchers about their network sharing.

2. Related work
2.1. Fertility evaluation based on GIS

Geographical information systems (GIS) are useful because they provide a framework for collecting, storing, analyzing, transforming, and displaying both spatial and non-spatial data for certain purposes (Paz, Sanchez, and Visconti 2006). Because the usage of the existing soil fertility evaluation methods is found to be difficult to visualize the fertility status of the soil in the entire study area (Liu et al. 2008; Li et al. 2011), researchers often use GIS technology to assist in fertility evaluation.

GIS technology is utilized to assess the soil fertility index as follows. Soil samples were collected with the selected grid according to the extent of the area. Then soil fertility indicators were selected. Next, the soil samples were analyzed by GIS software, and abnormal samples were removed. The value of the soil properties in the non-sampled area was estimated based on geostatistical analysis. In addition, the grid map layers of each soil fertility indicator were obtained. All the soil fertility indicators were standardized by membership function, and the weight of each soil fertility index was calculated. Soil integrated fertility index value was computed based on the grid layers and weight of each indicator; then, the soil fertility assessment map was drawn. These procedures were supported by the spatial analysis module of ArcGIS software. The specific process is shown in Figure 1.

2.2. Geographic Information Service

The OGC is a standard organization that focuses on spatial information. OGC standards are widely used within the scientific community to access and transmit geospatial data, such as Web Feature Service (WFS) and Web coverage service (WCS). Each service defines a protocol for requesting and receiving data from remote data providers. In addition to the standards for serving data, OGC has also established a standard for data processing called WPS (Amirian, Sampling Start Table data Check the data Kriging interpolation PCA, AHP, etc Individual index distribution Standardization: Membership function I FI value: Addition and multiplication IFI distribution map Clip The result map End

Figure 1. The process of the GIS-based fertility evaluation method.
Alesheikh, and Bassiri 2010). Given that WPS is particularly relevant to our works, this paper presents a detailed discussion of WPS.

### 2.2.1. Data service

Geographic data services offer a standardized interface to access geospatial data on the network. Meanwhile, OGC defines WCS and WFS interfaces for obtaining raster and vector data on the network, respectively. This standard also implements a standard geography markup language (GML) that directly supports WCS and WFS (Michaelis and Ames 2009). WCS specification defines the GetCapabilities, GetCoverage, and DescribeCoverageType interfaces. This service can access raster data through GetCoverage and request raster data descriptions through DescribeCoverage, such as the spatial resolution of data, the spatial extent of an effective spatial reference system, data formats, and the expected size of grid pixel value. The WFS specification defines the GetCapability, DescribeFeatureType, and GetFeature interfaces. Similarly, WFS can request description information associated with the feature data through DescribeFeatureType and return feature data through the GetFeature interface. All these interfaces are generated through GML encoding. In addition, WFS also permits clients to insert, delete, modify, update, and access feature elements in the feature instance library of the network. WCS allows client access to partial services information in accordance with the relevant constraints and query criteria. OGC also defines WMS with regard to request of map data from one or more distributed geospatial databases.

### 2.2.2. Process service

The OGC WPS was developed by the OGC organization recently as a standardized interface to define spatial processing services. The main goal of this service is to define an XML-based communication protocol for remote geoprocessing. The OGC WPS processes three key requests, namely, GetCapabilities, DescribeProcess, and Execute (Castronova, Goodall, and Elag 2013); it performs generic processing functions, such as projection/coordinate conversion, map overlay, and buffering. The GetCapabilities operation allows a client to request and receive service metadata in return (or Capabilities) documents that describe the capabilities of a specific server implementation. DescribeProcess permits a client to request and receive back detailed information about the processes that can be run on the service instance, including the required inputs, allowable formats, and outputs that can be produced. Execute allows a client to run a specified process implemented by the WPS (Chen et al. 2010b) by applying provided input parameter values and returning the produced outputs.

Based on the operations described above, the WPS interface standard can set rules to standardize the production of inputs and outputs (requests and responses) for geospatial processing services. The standard also defines how a client can request the execution of a process and how the output is handled (Chen et al. 2010b). Given that WPS presents a generic interface, it can be used to wrap other existing and planned OGC services that provide geospatial processing services.

### 2.3. Workflow

Workflow is used to describe and deliver business flow among various operations. Workflow modeling integrates workflow operations into a model to facilitate the automatic or semi-automatic execution of a business (Yang, Chen, and Di 2012; Favre, Fahland, and Völzer 2015). A workflow conceptual model is an abstract description of the business process workflow model generated in an application domain; this model is the first priority in building a workflow model.

Workflow facilitates scientific analysis through related calculations and data conversion tasks. This utility executes a series of complex activities without user’s intervention in addition to restructuring and reconfiguring workflow. With the continuous development of GIS and the proposed workflow technology, workflow ideas have been integrated into GIS-related software, such as the SpatialModeler of ERDAS IMAGINE and the ModelBuilder of ArcGIS. These software can be processed by dragging and dropping controls as well as setting related parameters to visually build and run the model. Subsequently, the return conclusion can be displayed. The model constructed by the aforementioned software program is strongly dependent on Utilization of software; moreover, no unified modeling standard has been set. Interactive operation is difficult to be realized as well; thus, the present research applies OGC standards to establish the proposed model as the standard service and implements a workflow model for network-based services.

Although OGC services can access data through the HTTP-GET/POST Link in the form of XML documents, the ordinary users may feel the services to be difficult. Therefore, this work requests data and functions through the activity form of the Windows Workflow Foundation (WWF) according to the workflow technology principle. This foundation can package complex data and functions as activities and access data and functions by calling the activity form. The proposed method can not only enhance human–computer exchanges but also be applicable for ordinary users.
2.4. Service chain

The service chain concept was proposed in the service system architecture specification of ISO19119, which is defined by ISO/TC211 and OGC (Cui et al. 2012; Zheng et al. 2016). This concept is also known as the service sequence, wherein the first service generates the next service in a sequence of services connected to one another. The existing service chain combinations include PBEL and Petri-Net, and the execution of such chains is managed by workflow engines (Yue, Gong, and Di 2010). A service chain can be defined by a workflow language (Yue, Gong, and Di 2010) and can be constructed by calling the related services. A user can perform related operations without knowing the specific function of each chain.

The GIS Web service is applied to process and operate both spatial data and space-related information. The GIS-based service chain provides technical support for distributed GIS integration (Yue, Gong, and Di 2010). At present, many people have implemented WPS service modeling according to workflow technology and service chain technology (Zhang et al. 2008; Xie, Yu, and Zhang 2011; Van der Aalst 1998, 2003). Zhang et al. proposed a remote sensing image processing system architecture framework for remote sensing data sharing and interoperation in Web environment with reference to workflow technology and OGC specification (Zhang et al. 2008). Xie et al. through GIS service chain to achieve a remote sensing image distributed processing based on Web services and workflow technology (Xie, Yu, and Zhang 2011). It has two advantages; first, data and function can be workflow or chain link to achieve complex data automation processing; second, through the network technology can share data and functions in the network, to achieve real-time online data processing, and avoid the user’s dependence on the local software. These applications are basically used to encapsulate the function to meet the OGC standard WPS service, there are still many problems. For example, the workflow model of these applications is all aimed at a specific task, and it is difficult to reconstruct or extend the existing model to implement other functions. Besides, its flexibility and universality are poor, and did not form a certain system.

Therefore, this paper puts forward a universal workflow conceptual model based on data and function that encapsulates the data and functions used for fertility evaluation into OWS-compliant data and functional models and uses Petri-Net to organize the models into processing chains. In addition, the model interfaces are customized to the corresponding activities in the workflow platform. Finally, network-based data and feature sharing is achieved by triggering activities in a certain order to call data and functional services.

3. Construction of the conceptual model

In this study, the workflow idea was considered in building a conceptual model for GIS-based fertility evaluation. According to the known sample data, the ordinary Kriging interpolation effectively predicts the data in unsampled area and is mainly used in soil classification and soil quality evaluation. Therefore, the algorithm of ordinary Kriging interpolation is introduced as the main fertility evaluation algorithm in the construction of such a model (Li. et al. 2011; Sun, Zhou, and Zhao 2003). ESRI data conversion and clip functions are provided as well. Figure 2 shows the conceptual fertility evaluation model that includes input/output, parameters, and the component

Figure 2. Conceptual fertility evaluation model.
circumstances of each function or algorithm. The attribute data of soil are regarded as input data for this model.

3.1. Universal conceptual model

The universal conceptual model includes data model, process model, and process chain model. **Figure 2** indicates that the model element is divided into two main categories, namely, data and functions, when building a conceptual model that encapsulates the data and functionality of fertility evaluation to meet the network service transport and call form requirements. For instance, the inputs/outputs and parameters of the model are integrated into the OWS data model. The processing functions are packaged into processing models that are consistent with the OWS standard to implement the distributed call of data and functions. Each processing model and data model is then organized into a processing chain according to a certain order by Petri-Net to compose services in a distributed environment. Multiple function algorithms can be nested into a processing chain via HTTP-POST to produce a processing chain and establish a specific function model.

3.1.1. Data model

The inputs/outputs and parameters of the fertility evaluation can be integrated into the OWS data model. The data in **Figure 3** suggest that the conceptual model covers vector, grid, and parameter data, including string and double types. To achieve data interaction on the network, a data mode must be developed. On referring to the OWS standard, **Figure 3** details the data modeling process involved in the fertility.

The data model includes the Inputs, Outputs, and Argument data types. These data types follow the OWS standard such that the vector data and raster data are incorporated into WFS or WCS as the input and output of the model. The bool, int, float, string, and double parameters are integrated through programming language encapsulation or are entered directly in the model.

3.1.2. Process model

The processing functions of the fertility evaluation are packaged into processing models that are consistent with the OWS standard to implement the distributed call of data and functions. **Figure 4** indicates that each module contains four parameters, Algorithm[], Inputs[], Outputs[], and Argument[]. Inputs[] and Outputs[] can be implemented by invoking the data model, whereas Argument[] can be realized by XML or another programming language. The function algorithm must be packaged into the universal standard service of the network to call functions in the network environment.

3.1.3. Process chain model

The process chain model is designed based on the processing model, which consists of a series of data and models that are defined as the description components of the chain. The relations among different parts are highlighted in **Figure 4**. A process chain model consists of a series of processing functions; therefore, such models maintain the relationships among processes to build a complicated model. In this study, a processing chain can be generated using Petri-Net. The relationships among the processes are described with this language as well.

3.2. Universal implementation of the conceptual model

To generate a universal fertility evaluation workflow model, data and process models must be built for each algorithm according to OWS standards. For example, all the data used in the fertility evaluation workflow model can be deployed as WCS and WFS services by GeoServer. The processing functions can are deployed as WPS services using 52° North. Accordingly, the processing chain for each processing model is constructed via Petri-Net to a certain order. **Figure 5** displays the general conceptual model.

The algorithm is incorporated into WPS; all the algorithms and data are integrated according to OWS standards; and all the data are expressed by GML. In particular, the service chains must be organized and connected through Petri-net for each module. The process service chain contains all the module operations and can be packaged into a single module that is nested to another process. Therefore, another processing chain can be called in a processing chain.

3.3. Workflow activities design of the conceptual model

The workflow platform can customize activities to build any activity required by the workflow, and it is also used in network services. A workflow activity enables professionals accomplish a specific task under
distributed data and functions. According to the concept model of Figure 5, the implementation of the workflow model mainly involves WCS, WFS, and WPS services. The interfaces of these services are DescribeProcess, Execute, DescribeFeature, and the other interfaces. These service interfaces are customized to the corresponding activities through the workflow platform, and the input parameters are exposed to the users as needed. Once the customized activities pass the test, users can drag them into any workflow model.

We transform OGC-standard functions into GIS activities through specific interfaces in Windows Workflow Foundation (WWF). Once the activities are customized, the activities will be connected smoothly through per-net on the workflow platform, and data and functions deployed on the network are invoked by triggering activity.

3.4. Operating mode of the conceptual model

The workflow platform is compatible with Web service-related activities and can pass custom activities to achieve a specific operation. Thus, a generic network workflow was developed through a workflow platform for the general conceptual model.

Figure 6 presents a sequence diagram model that introduces the messaging process model under the generic network environment. A client sends a request to a Process, which contains one or more modules. Each module encapsulates a function or algorithm and implements the required input and output parameters. Then, the Module service chain connects forming flow processes. The request must be incorporated into the data services by triggering the module. Subsequently, the data are sent back to the module, and algorithm-specific functionality is invoked through WPS. Finally, different WPSs are invoked to accomplish a specific task by triggering each module, and the final results are returned to the client.

4. Instantiation of the Web service workflow model

In this section, we describe the process of deploying the data and functions used in the fertility evaluation workflow model to network data and processing services that meet the OGC standard. The network services are transformed into OGC-standard activities by customizing the packaging of network service-related operations into activities. Finally, the specified function is executed by invoking the activities in the workflow engine. Furthermore, in order to demonstrate the flexibility and reconfiguration of the workflow model, the workflow model is reconstructed.

4.1. Study area and data preparation

4.1.1. Study area

Yidu City is located in the middle reaches of the Yangtze River (111.45°E, 30.40°N). This city is
situated in the western Hubei mountainous range within the transition zone of Jianghan Plain. Honghuatao Town is part of the northern city of Yidu and is the main source of grain, oil, and agricultural products. The area of the town is 149.0 km$^2$, of which 8.4 km$^2$ is the arable land. The town runs from northwest to southeast; alluvial plains are found along the river in the southeast. The topography is diverse, and the soil type is typical. Therefore, southeastern Honghuatao Town was chosen as the study area.

4.1.2. Data resource and its preprocessing

The distribution point method was employed along with a 200-m-spaced grid to examine the Honghuatao Town of Yidu City. The latitude and longitude coordinates of the soil sampling points were acquired by using GPS speed measurement technology, and the fertility parameters of the region were determined by combining physical and chemical analyses. A total of 391 soil samples were collected, and 16 data indicators were obtained, including soil organic matter, available phosphorus, total nitrogen, rapidly available potassium, pH, alkali nitrogen, total potassium, CEC, exchangeable magnesium, total chromium, available zinc, available iron, total phosphorus, exchangeable calcium, total lead and total copper.

The data preprocessing includes several steps. First, the 16 soil fertility indexes collected are checked, eliminate the outliers and test the normal distribution; Second, using the principal component analysis (PCA) method to select the evaluation index and determine the weight of each index (Li. et al. 2011); Third, the membership function is established for the selected indicators, and the indicators are
standardized by the membership function; Finally, the IFI value of each sample point data is calculated according to the addition and multiplication method. In this experiment, the Kriging interpolation method is used to predict the spatial distribution of IFI value and the evaluation indicators under network environment.

4.1.3. Software environment
Windows Server2008 r2 was utilized as a server operating system and Microsoft VS 2012 as a development tool. The C# language was applied for coding, and the .NET Framework 4.0 SP1 programming model was implemented. Other software programs are used including Tomcat6.0, ArcGIS 10.0, 52° North WPS 3.1.1, and Geoserver2.2.2.

4.2. Service deployment
Service deployment refers to the deployment of data and functions to servers on the network; for example, the raster or feature data are deployed into a WCS or WFS server. Different data and functions can be released into the same server or to varied servers. The workflow model obtains access to different servers when the algorithm or data must be called.

In this study, all the data used in the fertility evaluation workflow model are deployed by GeoServer. The processing functions are deployed as WPS services using 52° North. To optimize data and processing functions access, we utilize GeoServer to deploy the sample points of Honghuatao Town and the edge of the study area to WFS and WMS. The processing functions, such as Data Converting, Kriging Interpolation, and Clip, are released as WPSs by calling the ArcGIS Toolbox in 52° North. To ensure the security of the data transfer, we use the HTTPS protocol on the server side to encrypt the data transfer process.

```xml
<wps:Process wps:processVersion="2">
  <ows:Identifier>org.n52.wps.example.ags.custom.kriging</ows:Identifier>
  <ows:Title>Kriging interpolation</ows:Title>
</wps:Process>
<wps:Process wps:processVersion="2">
  <ows:Identifier>org.n52.wps.example.ags.custom.clip</ows:Identifier>
  <ows:Title>Clip interpolation</ows:Title>
</wps:Process>
<wps:Process wps:processVersion="2">
  <ows:Identifier>org.n52.wps.example.ags.custom.DataToConvert</ows:Identifier>
  <ows:Title>DataToConvert interpolation</ows:Title>
</wps:Process>
```

Figure 7 shows the WPS deployed in 52° North. We can access data conversion, Kriging interpolation, and clip services through http:// 122.205.95.102:8032/wps/WebProcessingService?

Request = GetCapabilities&Service = WPS& version = 1.0.0. The DataToConvert, Kriging, and Clip services perform data conversion, Kriging interpolation, and clipping functions, respectively. The URL
for the WFS deployment is http://122.205.95.102:8032/geoserver/wfs?VERS1ON=1.0.0&SSErVICE=WFS&request=GetCapabilities#cq:Point.

4.3. Construction of the universal workflow model

After the service deployment, the fertility evaluation workflow model is built through WWF platform, and the workflow model performs three functions, namely, data conversion, Kriging interpolation, and clipping, through the Execute activity. This flow involves six procedures, as shown in Figure 8.

1. The published sample point data are obtained. Detailed information regarding the sample point is derived through WfsGetCapabilities. The sample point data stored in the server are converted into the local XML format by utilizing the GET function of WfsGetFeature.

2. The WFS sample point data should be converted into a local vector format file for convenient}

Figure 7. WPS activities based on 52° North.

Figure 8. Activity diagram of the fertility evaluation workflow model.
data processing and calculation. The WFStoShpGetCapabilities activity can be applied to access description information on data conversion services, and the WFStoShpDescribeProcess activity can be applied to access the data conversion algorithm. WFStoShpExecute is used to convert data by setting the input and output data of the conversion algorithm. Through the operation described above, the sample point data of the deployment are converted locally.

(3) Assess whether the conversion of decision data is successful or not. If the process is successful, the Kriging interpolation is performed; otherwise, the judging function is run 10 s later in the Delay activity.

(4) The conversion result should be derived through WfsGetFeature during Kriging interpolation. The KrigingDescribeProcess is run on the network using the GET function. The I/O parameters are set in KrigingExecute. The interpolation result is expected to be a raster feature.

(5) Analyze whether the conversion of decision data is successful or not. If the process is successful, the Clip process is performed.

(6) The Kriging interpolation result is derived through WcsGetCoverage. MaskDescribeProcess is run with the GET method to obtain the Clip function. Once the I/O parameters are set in MaskExecute, we finally obtain the evaluation map by running the Clip function. The interpolation factor can be changed by modifying the parameters in KringExcute as necessary.

Figure 9 shows the results of the fertility evaluation model, that is, IFI distribution and organic matter distribution map, respectively. The results are the same as the local ArcGIS software run results: soil quality in IFI distribution from low to high with gray to black color, the northwest and southeast of the highest, the western region of the lowest; In the organic matter content distribution map, the organic matter content in the southeastern part is the highest, and the organic matter content is gradually decreased from the middle to the east, west and north.

4.4. Reconstitution of the universal workflow model

Because the universal workflow model has strong flexibility and reconfiguration, we can reconstruct the workflow model. As shown in Figure 10, the first to fourth functions in the generic workflow model are encapsulated as a workflow model, and then nested the workflow model into another workflow model that contains a clipping function, in order to realize the Kriging interpolation results are tailored.

The workflow modeling approach is scalable and can be extended on the basis of this workflow model for other scientific task analysis. For example, it can increase the function of raster calculators to extract better and poorer areas, thus reducing the data analysis of relevant users. At the same time, the universal workflow model not only can be used for fertility evaluation in the study but also can be used for land use change, the annual precipitation change analysis and related data processing, to help researchers reduce the workload and realize cross-platform cross-regional data processing.

5. Conclusions

To find a method to automate the evaluation of soil fertility without relying on local software, we constructed a universal workflow conceptual model of the fertility evaluation based on workflow technology and OGC specification. Then, we take Honghuatao Town city of Yidu as an example, sharing the data and functions on the network for fertility evaluation, and the fertility evaluation is automatically achieved by

![Figure 9. Distribution of the integrated fertility index and organic matter.](image)
The way of workflow modeling in the network environment. The main advantage of workflow modeling is reusability. Thus, the fertility evaluation model can be separated into conceptual models with stable processing capabilities and flexible input parameters, and the conceptual model can be applied to instantiate by workflow technology to improve fertility evaluation efficiency. Moreover, the fertility evaluation model is applicable to ordinary users, and we can obtain fertility evaluation results by calling the model on the network, without understanding the relevant professional software and professional knowledge.

The results also indicate that workflow technology can integrate analysis methods and convert the conceptual model into an executable program, and the constructed workflow model can invoke the data and processing functions distributed on the network. Thus, a network fertility evaluation model can be feasibly constructed in the workflow by analyzing fertility evaluation processes. In addition, this paper describes the method based on workflow technology to share data and functional networks, which is not only suitable for in fertility evaluation but also can be used in other related fields. It also provides ideas for the relevant researchers to achieve network sharing.

Nonetheless, the method for building the workflow model based on the network also has its drawback. For example, when the data service provided by the third party has a quality problem and the service is unusable, it cannot obtain the service. Therefore, it has high dependency on the acquired input service quality. This will be a direction, and we need to improve in the future. In addition, the current study achieved only semi-automatic fertility evaluation, and the normalizing indicators and calculating integrated fertility index are not nested into the model. Further research should be conducted to extend model functions and workflow automation, which will be our future focus. We will introduce raster calculator functions to realize normalization and calculation of the indicators IFI value and make the function more perfect fertility evaluation model.

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