Remote Sensing Applications in Agricultural Statistics at China NBS

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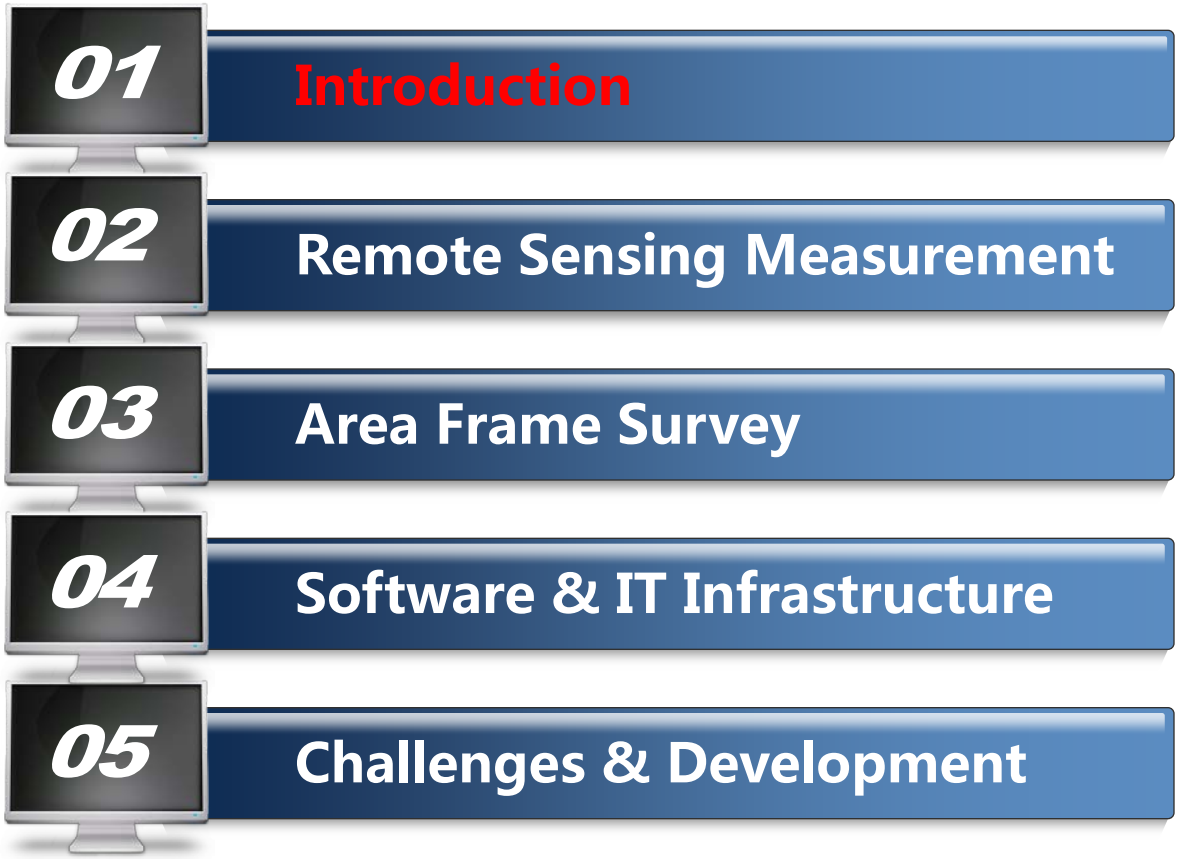
Outline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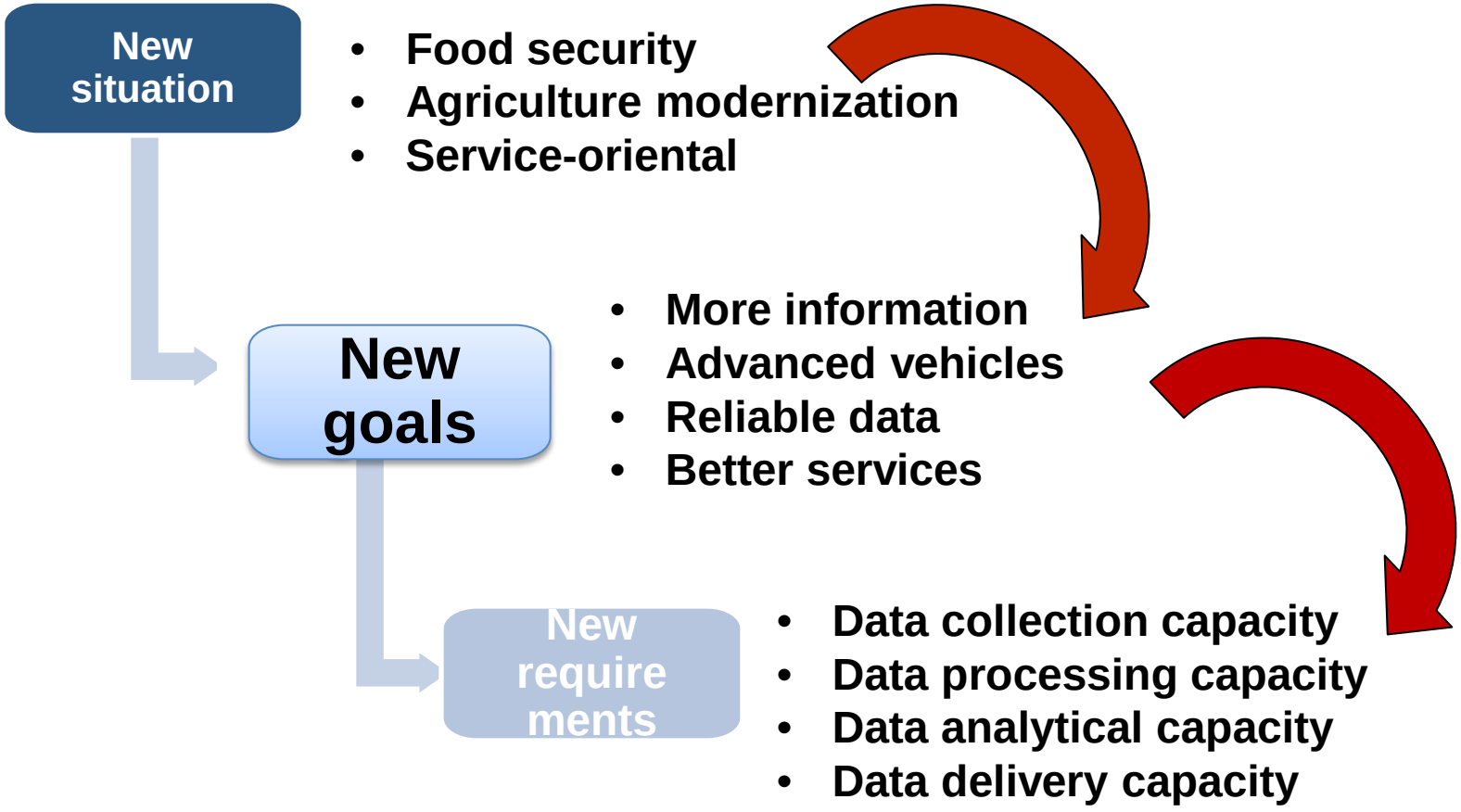
Challenges & Development

The new requirements of agricultural statistics in 21th century.

- **Provide relevant data for policy making to ensure national food security.**
  - Food security has the highest priority for the development of modern agriculture.
  - Agricultural statistics are vital information for grain development strategy.
  - The international situation, the rapid development and profound change of agriculture and rural area in China brings up the new requirement.
- **Meet the data gap for modern agricultural development.**
  - Grain Production Counties Development Strategy has implemented, which requires to set up statistical monitoring and evaluation system.
  - The strategy of developing facility-based agriculture and standardizing horticulture production was set up, which requires corresponding statistics.
  - The innovation of agricultural technology integration, mechanizing and informatization, new survey tools should be applied for these new farming.
  - To enhance the agricultural production with social services supporting, agricultural statistics should be service-oriented, providing more relevant information to producers.
- **To meet the needs of multi-dimension services.**
  - Markets needs timely, accurate, transparent information.
  - Large and small area statistics are all needed.
  - The data are needed for all major crops, include commodity crops and minor crops.
  - Information for food quality, its production and marketing are all needed.

The new requirements of agricultural statistics in 21th century.



Can the traditional agriculture statistical system meet the new requirements of 21th Century ?

Traditional agricultural statistics become unadapted

Survey schemes

- The merging of sample survey and complete reporting.
- Does the sample designed for province population meet the needs of county and prefecture level?
- How to adapt the rapid change of farming structure ?

Counting units

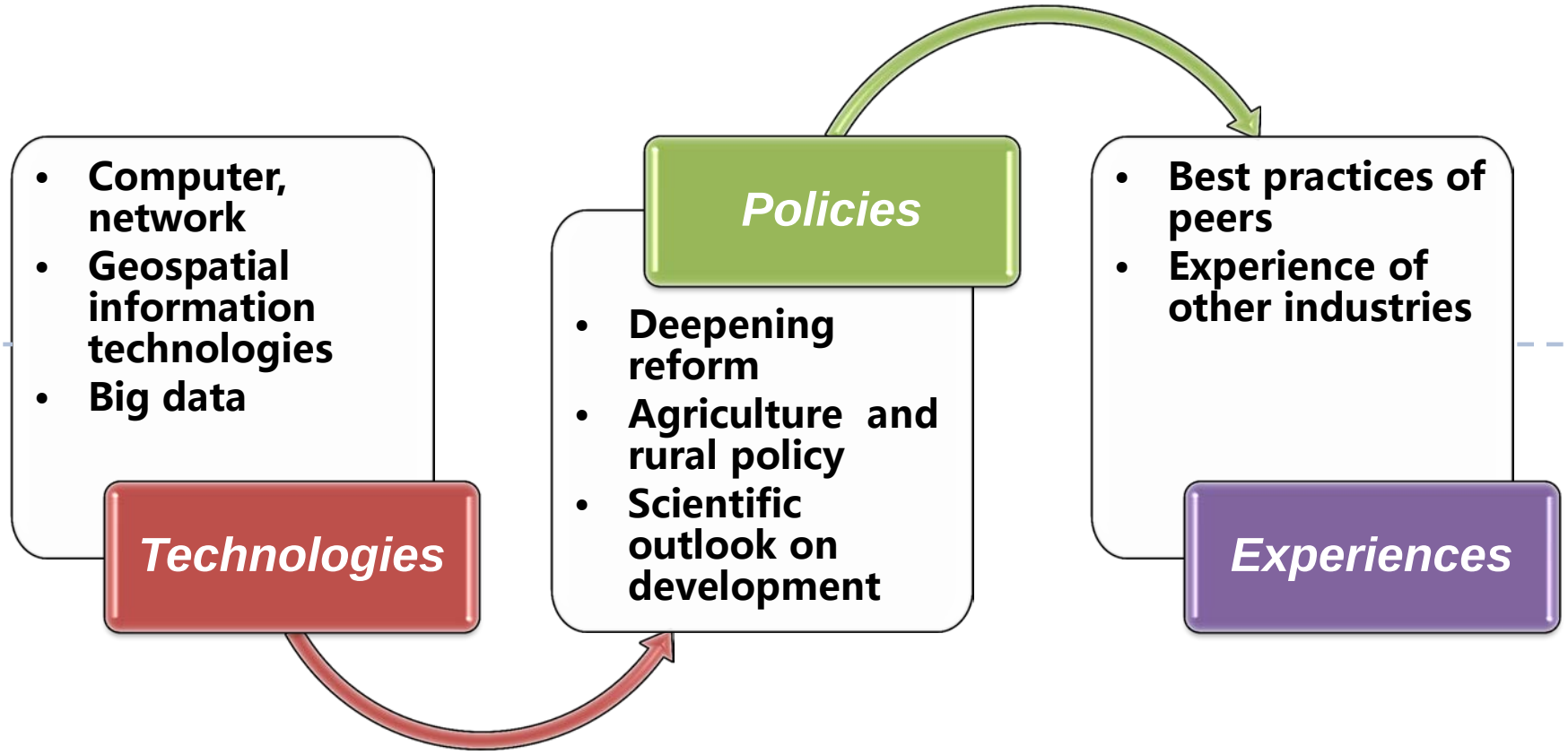
- Mobility of sample farmers.
- Rapid change of Land tenure.
- Impact of sample farmer’ s subjectivity.

Survey tools

- Mainly traditional tool, such as self-report, compass and rope.
- Cannot efficiently deal with estimation under disaster or other rapid change
- Lack of necessary supervision and management.

Traditional agricultural statistics cannot meet the new requirements well.

The support of new technologies



Importing new technologies, improving agricultural statistics.

Geospatial information technologies

Geospatial information technologies (3S) include Remote Sensing (RS), Geography Information System (GIS) and Global Positioning System (GPS) , combined with computer and network, applied for measurement , collection, storage, management, display, analysis, spreading and application of geospatial data. In USA, Geo-IT has become one of the three hottest occupations (with Biotechnology and Nanotechnology).

The ability of earth observation

- Big range
- High resolution

The ability of geospatial data management

- Huge volume data
- Visualization

The ability of positioning

- Location
- Navigation

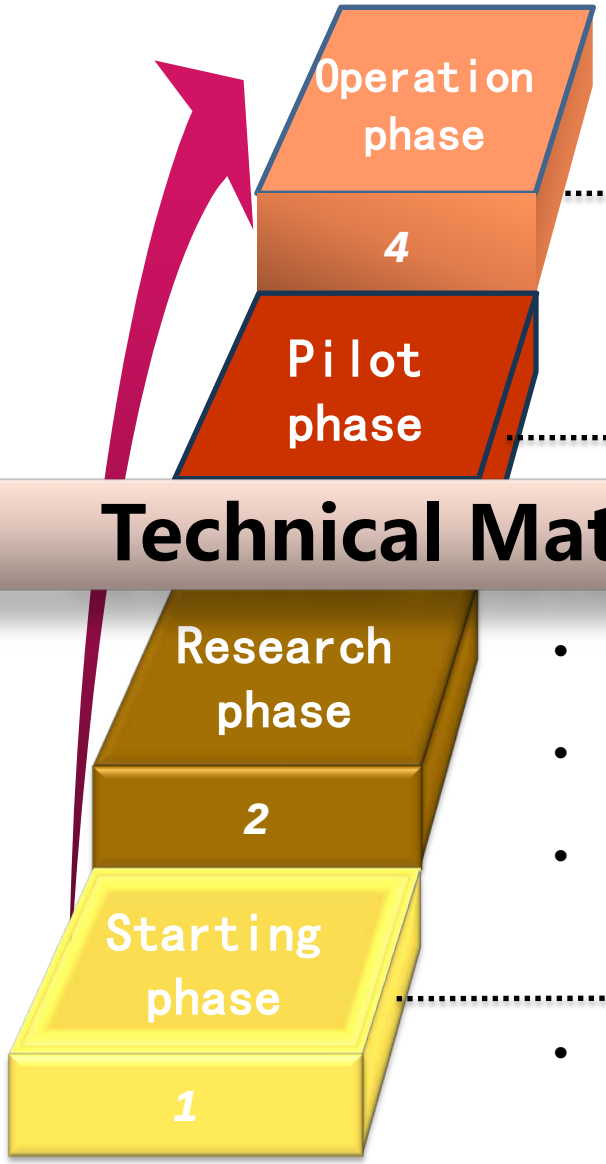
Geo-IT and agricultural statistics can be naturally integrated.

Remote Sensing

GIS

NSS

中国农业统计遥感发展历程



- Crop area frame survey 2009年

- Xinjiang cotton remote sensing measurement 2010年
- Crop area remote sensing measurement pilot 2009年

Technical Maturity →Pilot→ Implementation

for agricultural surveys 2012年

- Earth observation project -- Pilot of high resolution remote sensing for statistical surveys 2011年
- Industry project -- Data source pilot of remote sensing for agricultural surveys 2009年
- 863 project -- The research of key technologies for statistical surveys 2006年

- 863 project -- The research of norm and application of remote sensing for agricultural surveys 2003年

The research of key technologies for operational implementation of agricultural statistical remote sensing

- **National research project to produce of key technologies**

  Crop remote sensing identification methodology.

  Using geo-spatial technology to build area sampling frame for agricultural surveys. …

- **Using pilot to promote the transformation of research results of key technologies**

  Crop area remote sensing measurement pilot will improve crop identification methods with the terrain characters and imagery availability for different regions, and develop methodology operational for specific region. …

- **Use demonstration application to break through the nexus of operational application of key technologies**

  Crop area frame sampling survey will integrate the geo-spatial frame building, geospatial sampling, and other new technology. …

Building two major agricultural statistical surveys system with remote sensing.

- **Crop area frame surveys**

Beginning from year 2010, crop area frame survey has been carried out at Jiangsu, Henan, Liaoning, Jilin Hubei, Anhui with county-level as population, which has replaced the traditional list-based crop survey. The building of work base for survey have completed and seasonal survey has been carried normally.

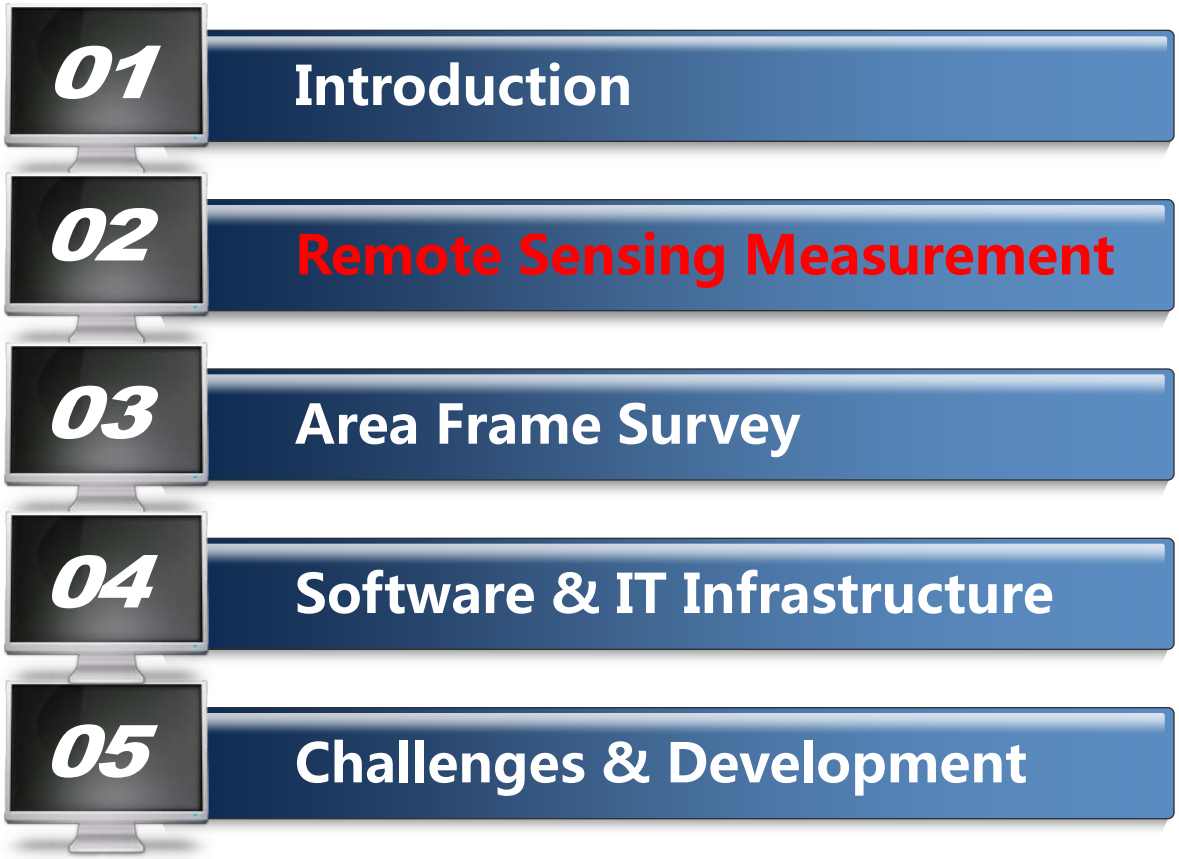
- **Remote sensing measurement**

Beginning from year 2010, remote sensing measurements have been implemented at Beijing, jiangsu, Henan, Hubei, Jinlin, Liaoning, Ningxia, East part of Inner Mongolia for summer and autumn grain crops. Unmanned aircrafts(drones) and other new survey tools were used for survey and a technical system was built for operational field survey.

Improving the survey tools for agricultural surveys

The first agricultural survey vehicle was developed, which integrated satellite imagery, aero-photography, field observation. So high resolution images, roadside picture and video, field agro-parameters will be collected and combined together to distill useful data for estimation. The data collection capacity of geospatial samples for crop area, growing condition and yield was formed, which provide a solution for completely, rapidly and accurately data collection for estimation of crop area, crop condition and total production.

Outline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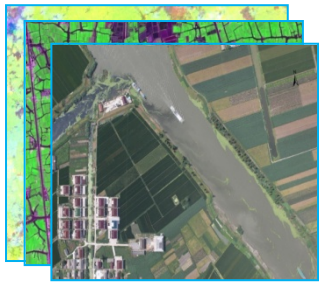
Current crop area remote sensing measurement

Crop area remote sensing methodology was developed, which includes data collection and processing, remote sensing classification, field survey, validation, error correction and producing ASCDL as major functions.

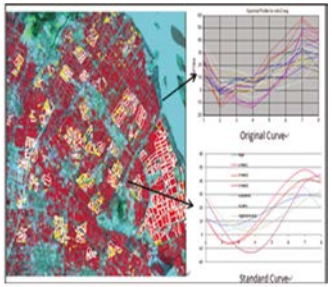


Imagery acquirement

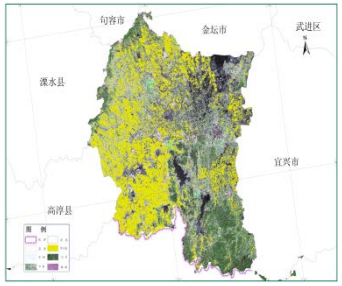
PDA survey

UAV survey

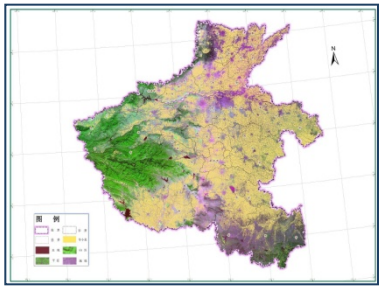
Field survey



Identification

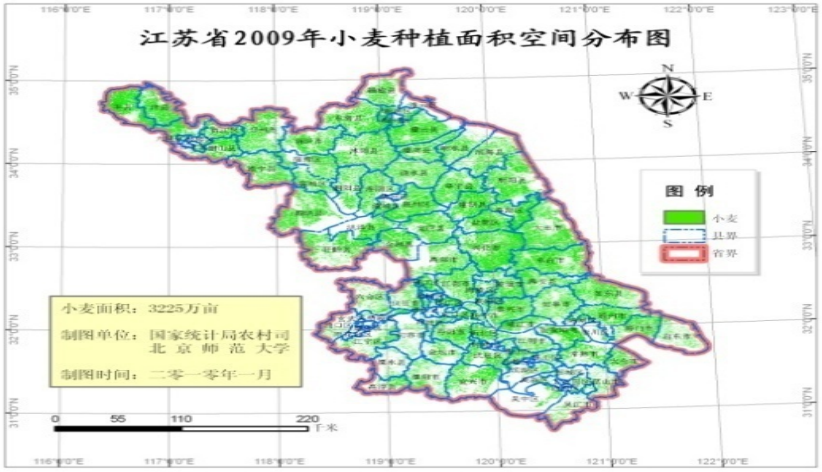


County estimation



Provincial Estimation

Provincial identification



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无锡市	宜兴市	375448	南通市	如皋市	578412
徐州市	鼓楼区	57814	南通市	通州市	326172
徐州市	云龙区	36287	南通市	海门市	47526
徐州市	九里区	29050	连云港市	连云区	21640
徐州市	贾汪区	259455	连云港市	新浦区	232018
徐州市	泉山区	2853	连云港市	海州区	68789
徐州市	丰县	789521	连云港市	赣榆县	488012
徐州市	沛县	662601	连云港市	东海县	1141752
徐州市	铜山县	978548	连云港市	灌云县	866255
徐州市	睢宁县	1043009	连云港市	灌南县	536812
徐州市	新沂市	741544	淮安市	清河区	18178
徐州市	邳州市	757916	淮安市	楚州区	720659
常州市	天宁区	850	淮安市	淮阴区	709534
常州市	钟楼区	4026	淮安市	清浦区	121487
常州市	戚墅堰区	668	常州市	新北区	162351
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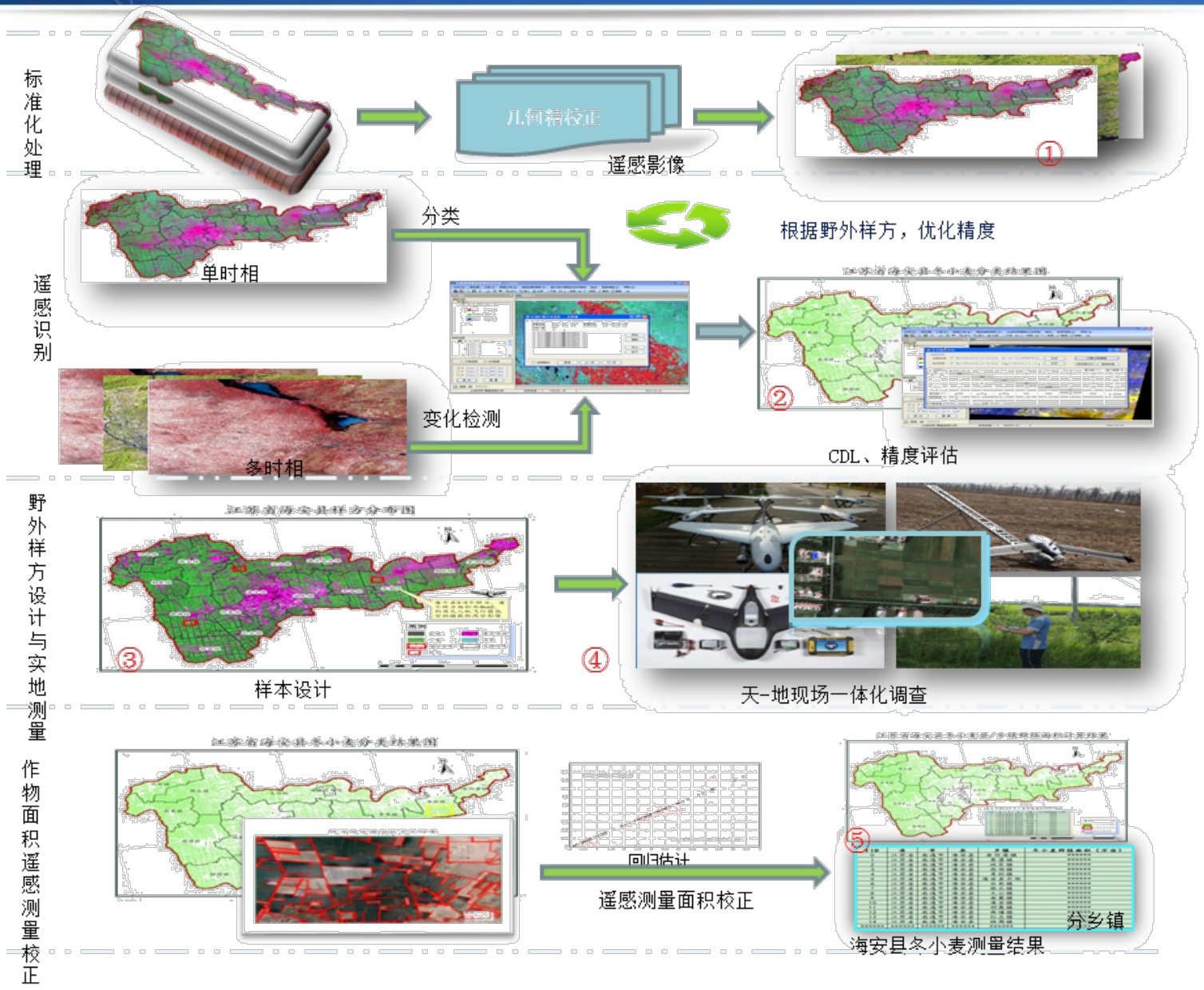
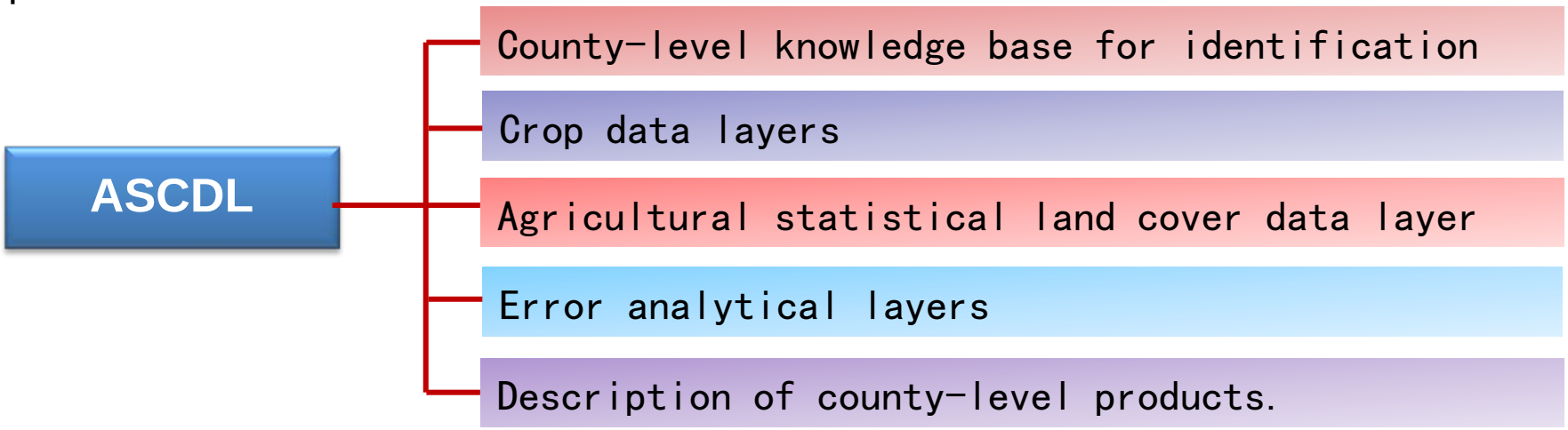
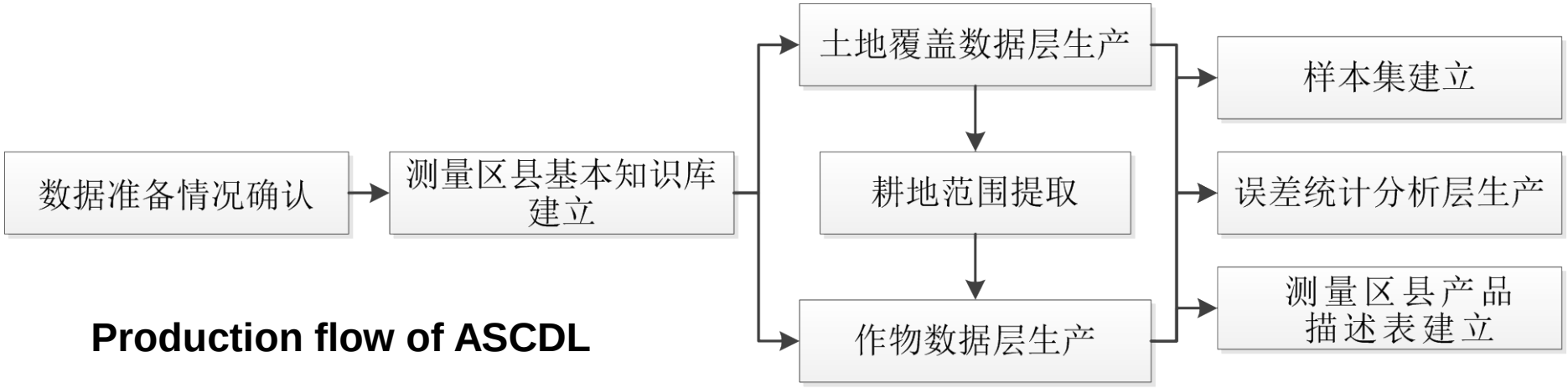
Technical procedures



Remote sensing identification

Based on the current multi-phase remote sensing data, land cover (arable land included) were extracted and crop identification were made and finally ASCDL was produced.



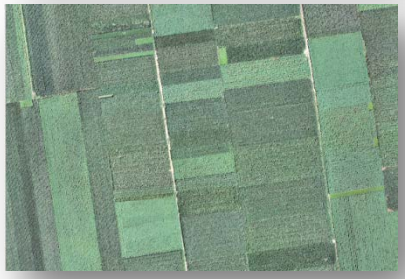


Production flow of ASCDL

Field survey and sample interpretation (1)

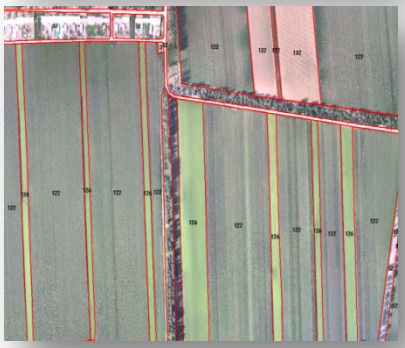
For the selected field sample, with the support of region office, UAV field survey was carried and aero-photography was captured and crop plots were delineated.

Field work photos



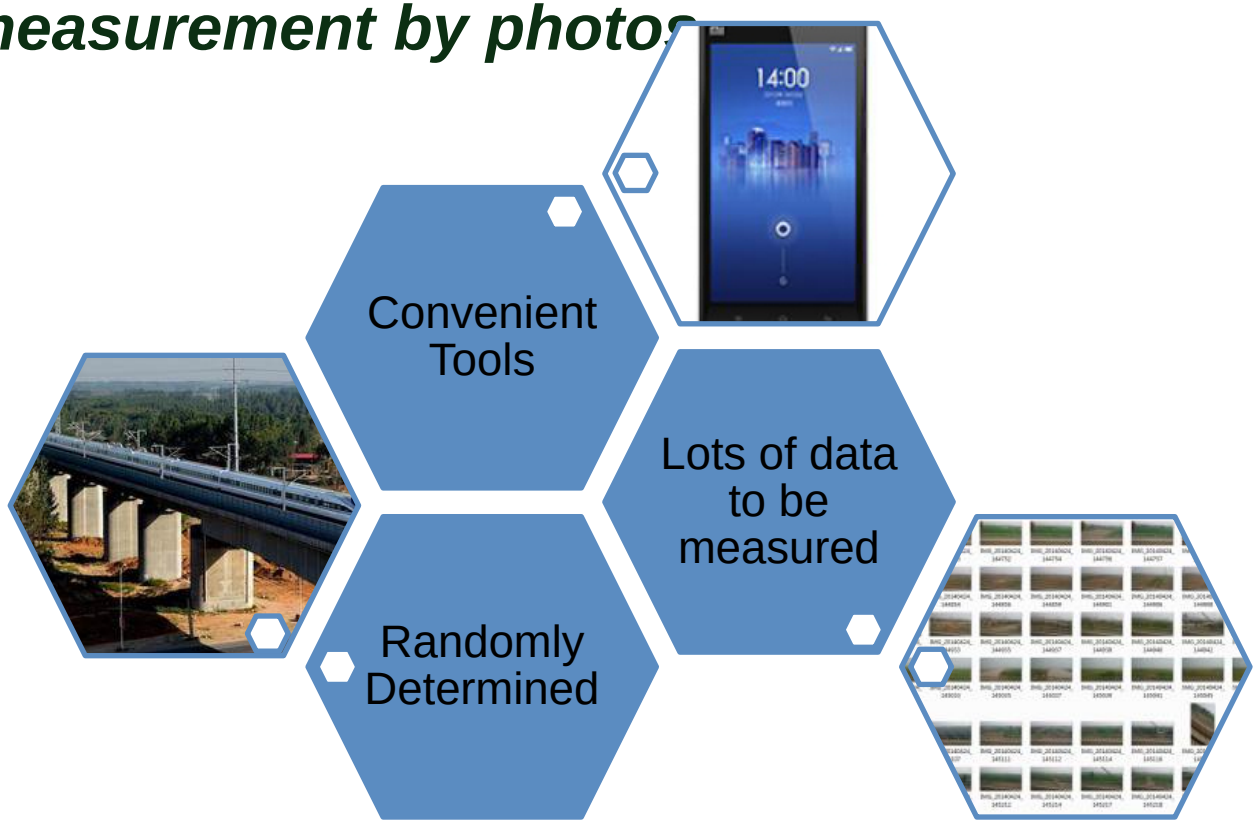
UAV photo mosaic

Vectorization of sample land



Field survey and sample interpretation (2)

- ***Photo Captures by RPV or Mobile Devices（Tablets, smartphones）***
- ***Area measurement by photos***



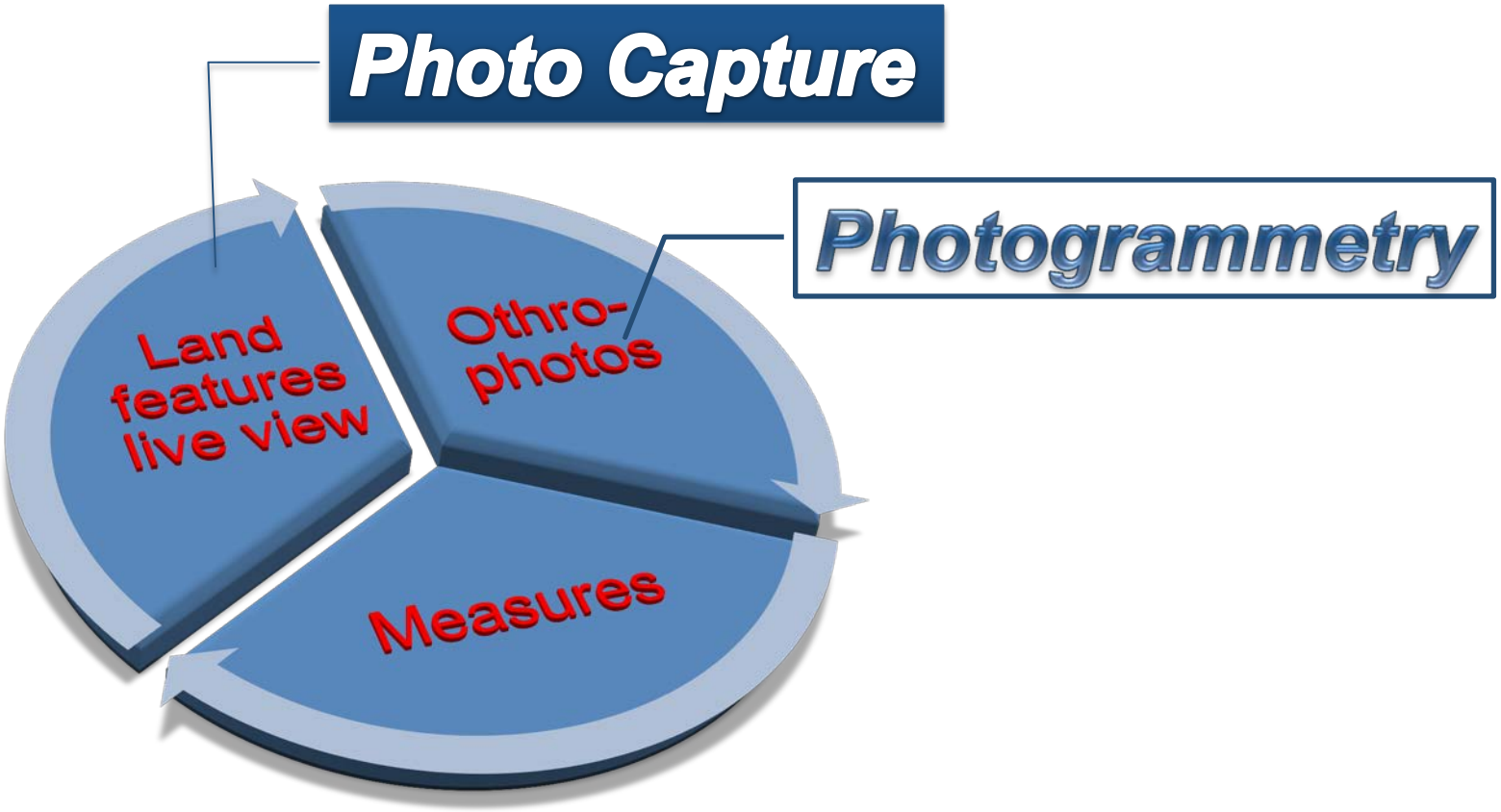
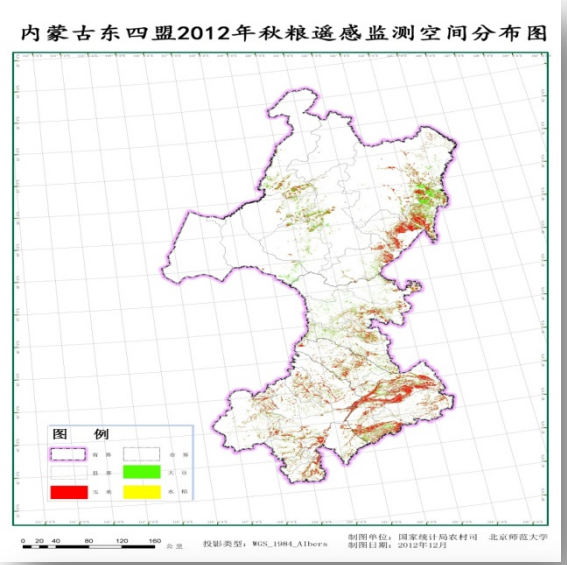
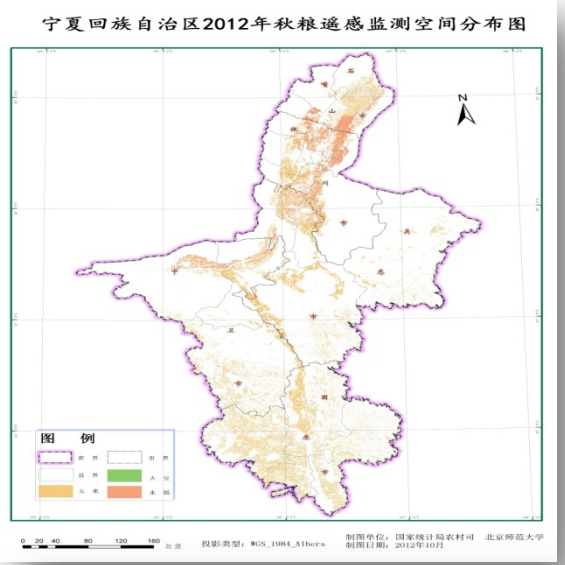
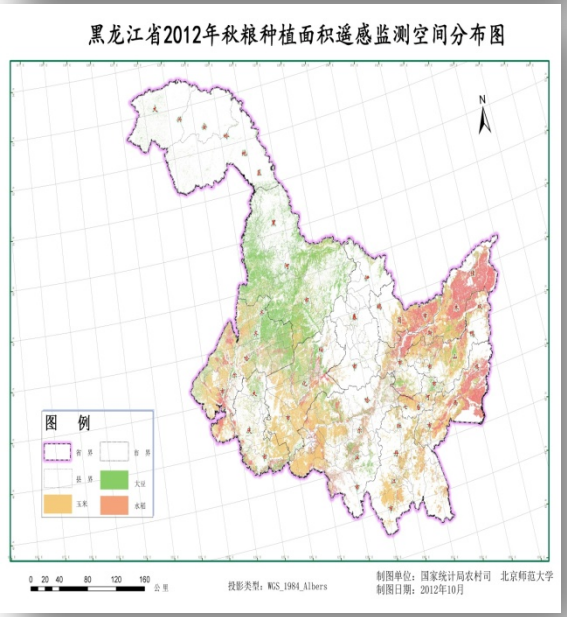


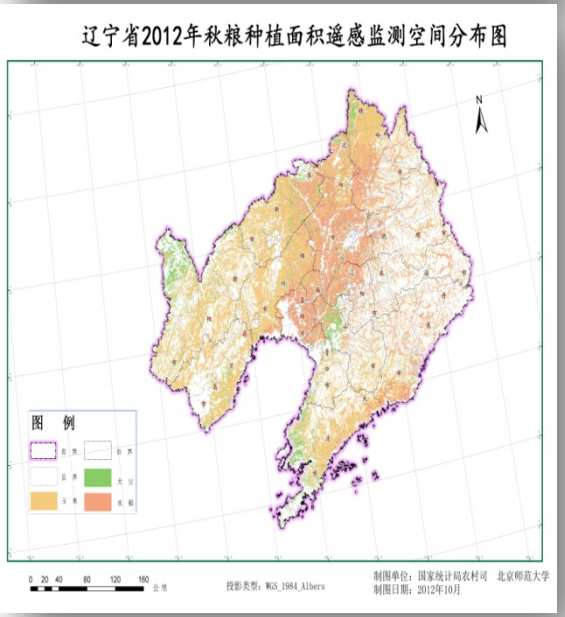
Photo Capture
Photogrammetry
Land features live view
Othro-photos
Measures

Results of remote sensing identification





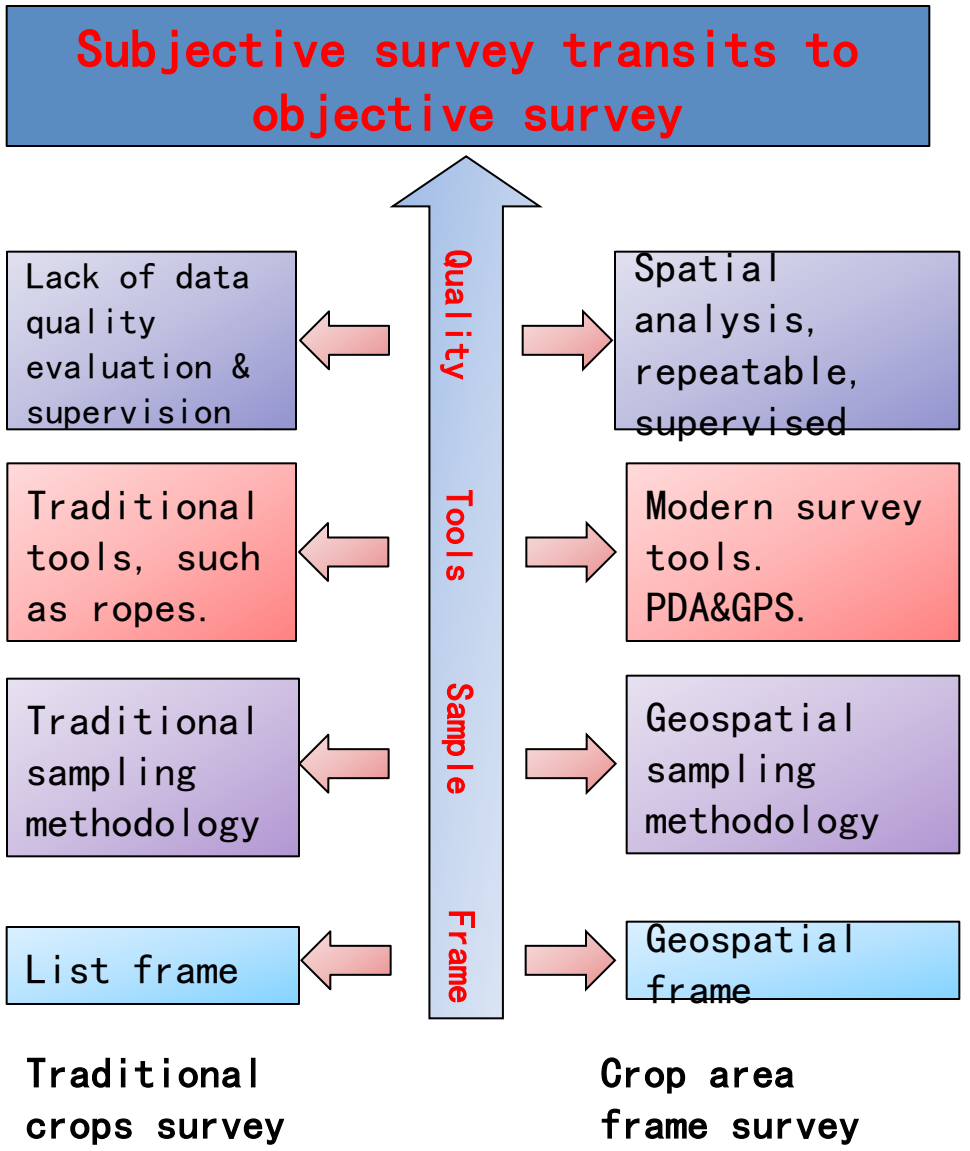




Outline

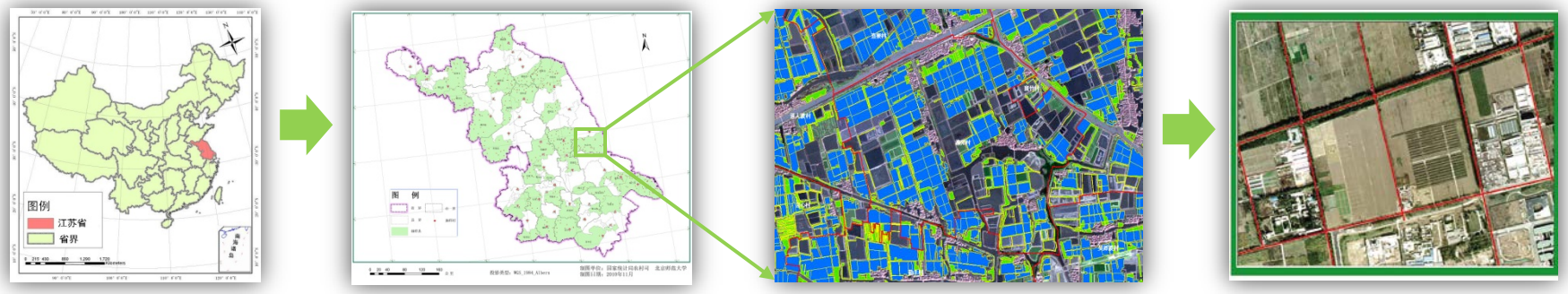
Start point

Area frame was built with 2nd agricultural census data and 2nd land use census data. cropland segments were created as sampling unit and enough segments were sampled to meet the precision requirement. Several direct interviews of segment planting were carried by interviewer to estimate the crop area. According to the harvest season of crops, certain planting plots was selected for crop-cutting and then the yield of specific crop was collected and estimated. Finally, the crop production was estimated.



Crop area frame survey system

A primary system for crop area frame survey was developed, which includes geospatial sampling frame, segment sampling, field survey, survey data submit, estimation, quality evaluation. Detailed data on fields are collected and measuring precision is improved. The goals to change the counting unit from list to spatial fields were realized.



Province　　Sample county　　Sample village　　Sample plot

crop planting area estimates and variances of the Pilot counties in 2009

Pilot county name	辽宁法库县	河南濮阳市	江苏溧阳市	吉林德惠市	安徽凤台县
对地抽样方法	空间随机抽样	空间随机抽样	空间随机抽样	以规则网格为初级抽样单元的分层两阶段抽样	农普与土地利用数据相结合的两阶段抽样
标准地块面积（ha）	6.0	5.0	2.0	7.0	2.0
标准地块数量（总体）	25658	20421	87103	30442	33850
行政村数量（总体）	334	1033	360	285	282
标准地块数量（样本）	256	204	871	240	180
行政村数量（样本）	159	170	258	80	60
作物名称	玉米	玉米	水稻	玉米	水稻
总体总值估计值(m^2)	1196107178	598069619	393651628	1486401968	900946045
CV(%)	2.35	4.32	4.95	4.81	4.92

Developing of sampling frame

- **Cultivated land updating**

By visual interpretation or change detection with current satellite imagery, the cultivated land polygons from the 2nd land use census data were updated for more accurate, complete cover and no missing.

- **Identification of major crops**

Using remote sensing images to identifying major crops to acquire more ancillary information. Depending the situation of data acquirement, change detection and unsupervised classification method are used for identification of target crops.

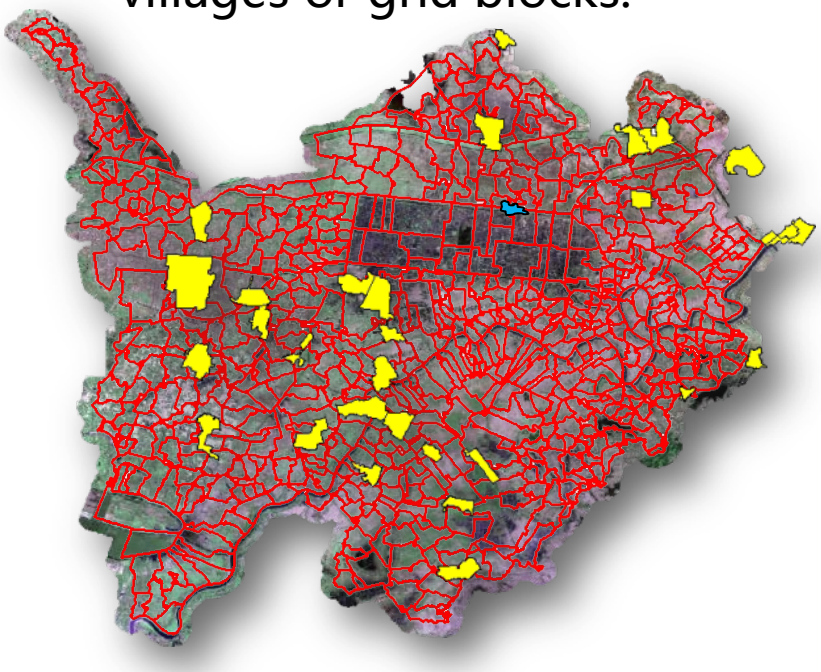
- **Sampling units construction**

Division with administrative area : The cultivated land polygons are divided with administrative boundaries and the identification results was summed up by crops for each administrative area.

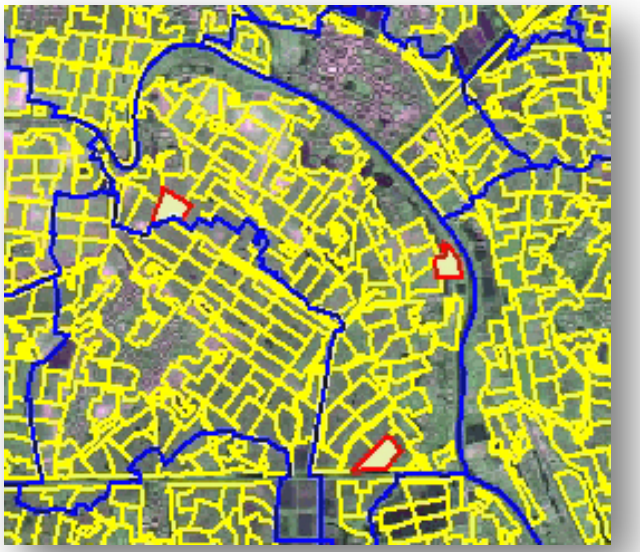
Division with grid delineation : Land polygons were split into grid blocks of same size, and the identification results was summed up by crops for each block.

Sampling

- **Two stage PPS sampling**
  - **First stage:** Primary sampling units, which are villages or grid blocks, were sampled.
  - **Second stage:** Land segments were selected with SRS within sampled villages or grid blocks.



Sampling of villages

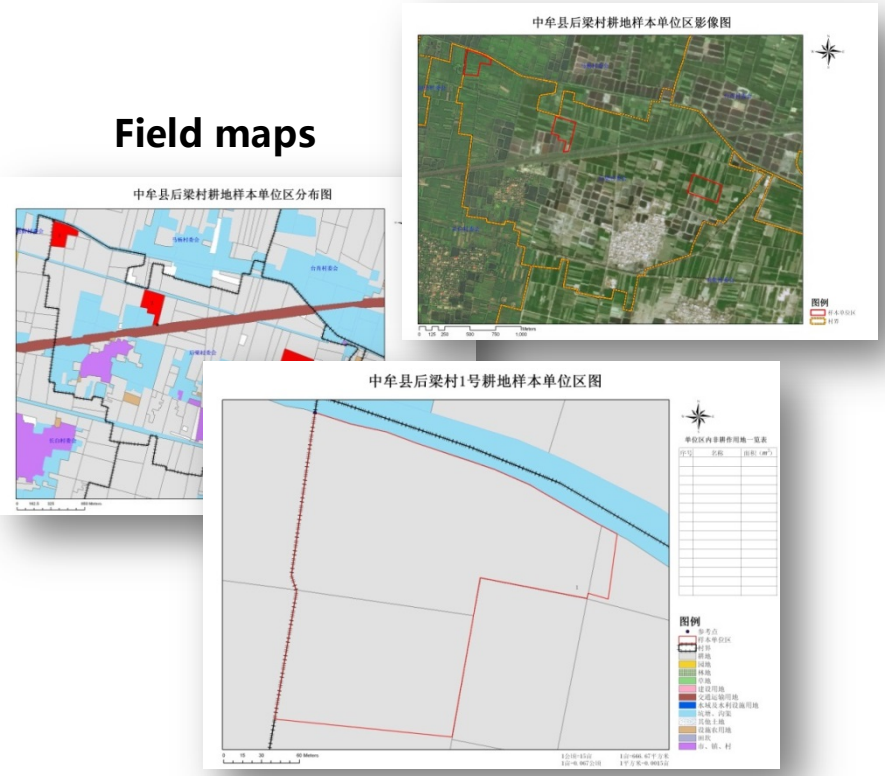


Sampling of land segments

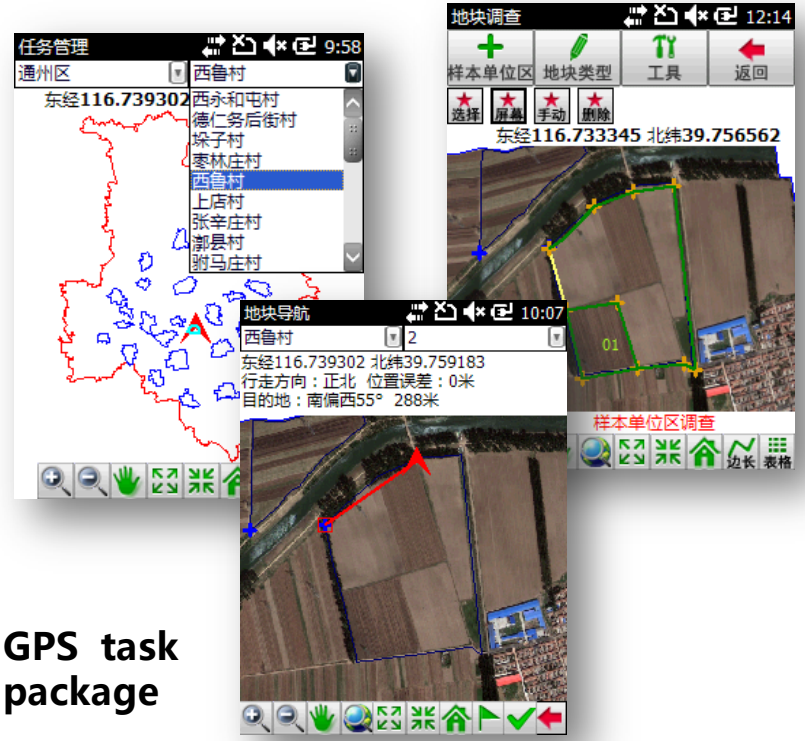
Field work package

- Field maps suites : Hardcopy image of sampling villages, vector maps, maps of sampling segments.
- GPS task package : GPS devices are needed for area measurement of the screening survey. All the task base data and forms are packed into task package and loaded into GPS.

Field maps

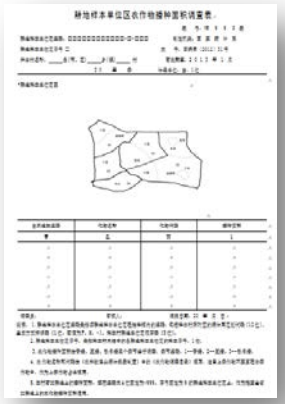


GPS task package



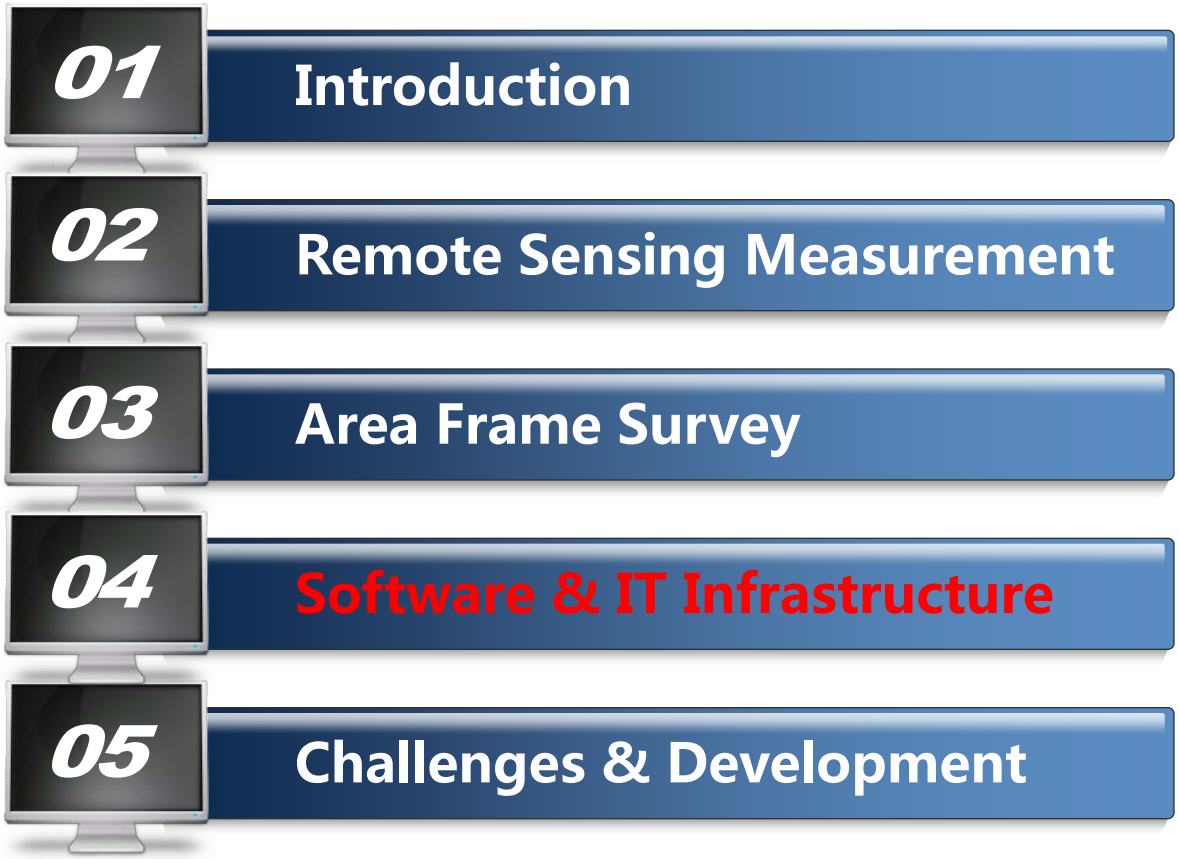
Field survey methods

- **Screen survey**
  - **Sampling segment screen questionnaire: Collect data at the beginning of each survey round. Location, crop used area, non crop used area, field splitting, and users data are collected.**
  - **Sampling village questionnaire : Collect data at the end of each year.**



- **Seasonal survey**
  - **Cropping intention survey : Farmers’ planting intention and plan are carried at sampling segment before winter planting and summer planting. 10 farmers will be selected for survey at each sampling village.**
  - **Crop area survey : Carried at winter planting, spring planting and early rice planting, summer planting period. Crop area are collected from sampling segments directly.**
  - **Crop yield and production survey : Carried at summer harvest, early rice harvest and autumn harvest.**

Outline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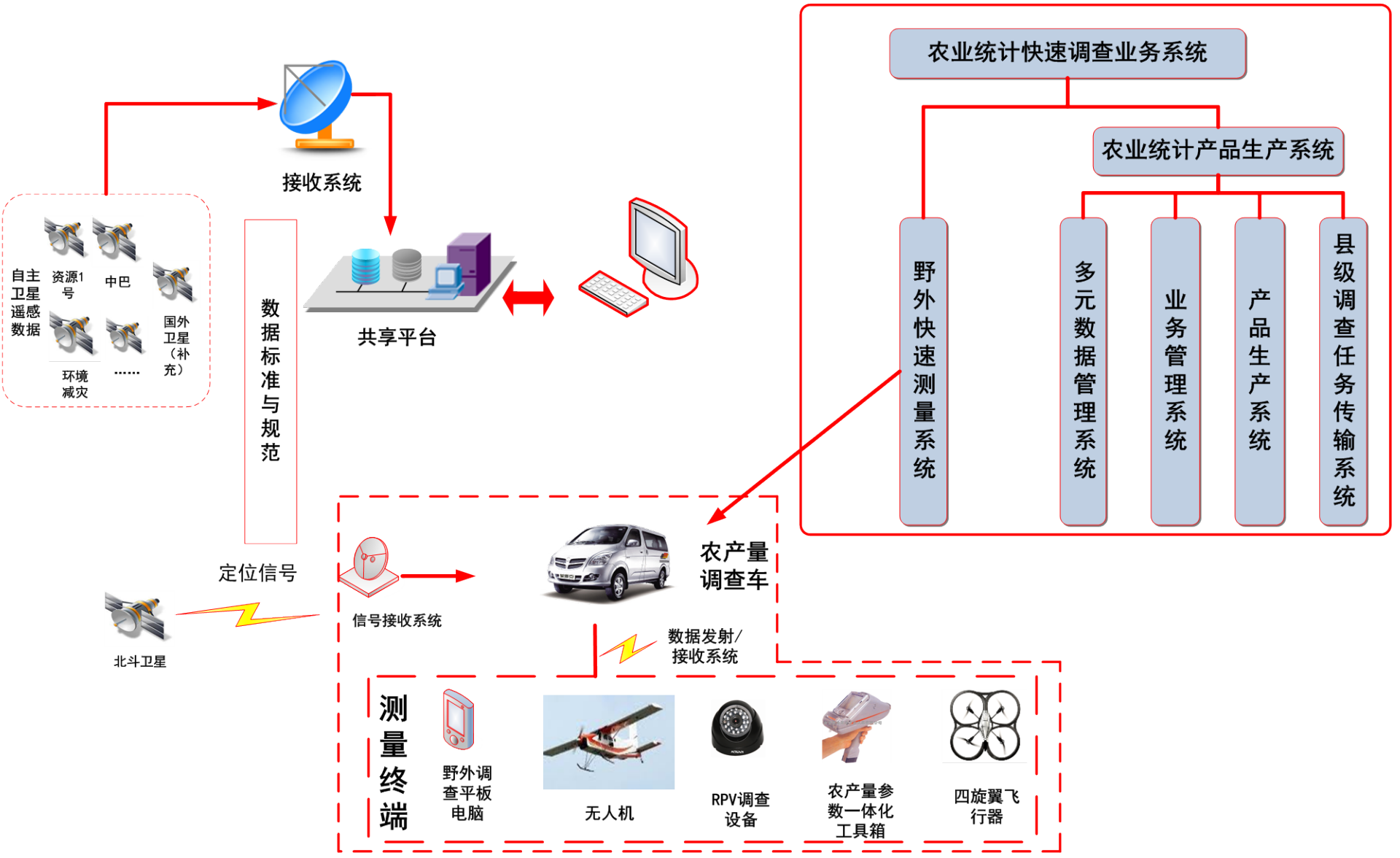
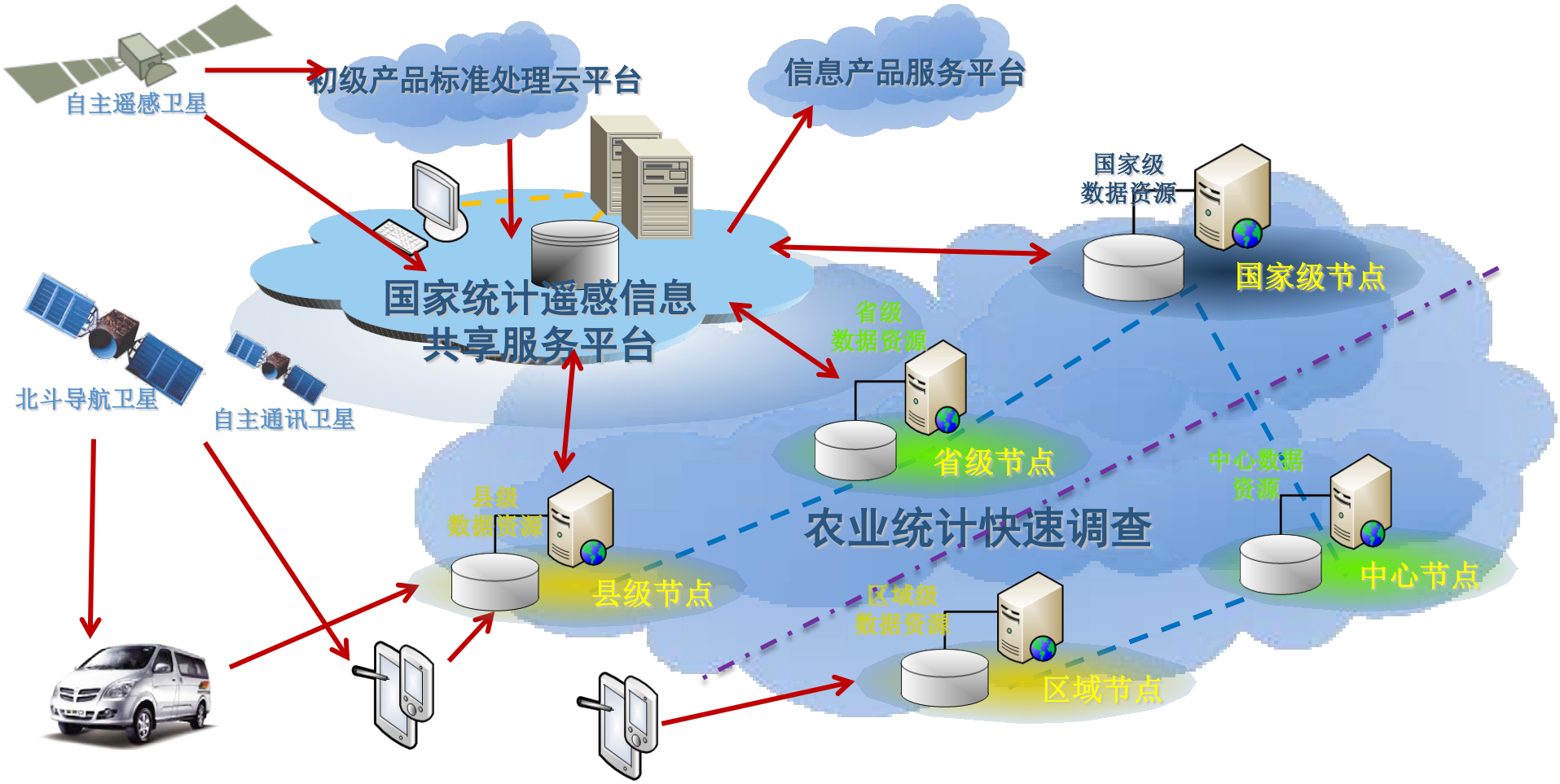
Integrated service platform for agricultural rapid survey.



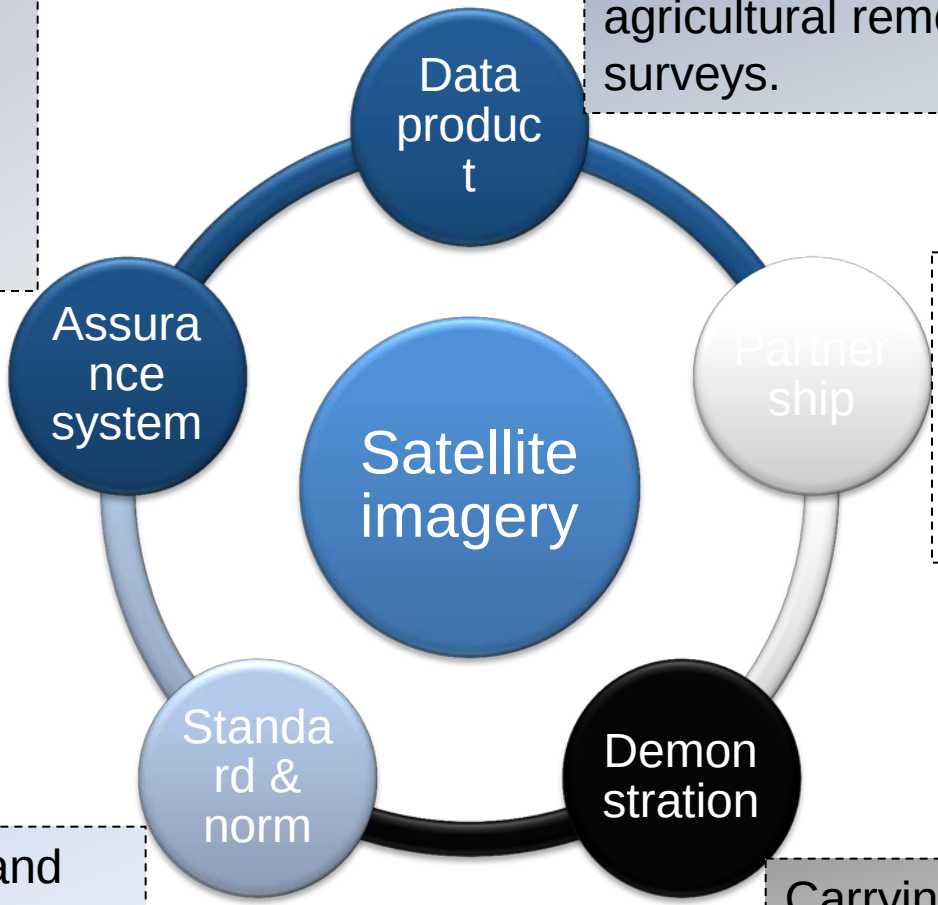
Overall framework



Data source system

Developing the agricultural statistical remote sensing data source assurance system to provide required satellite imagery.

Producing and providing data products for operational agricultural remote sensing surveys.



Exploring the data partnership with line ministries & business firms.

Developing standard and norm of satellite imagery data product for agricultural remote sensing surveys.

Carrying out provincial demonstration application

Agricultural remote sensing survey infrastructure

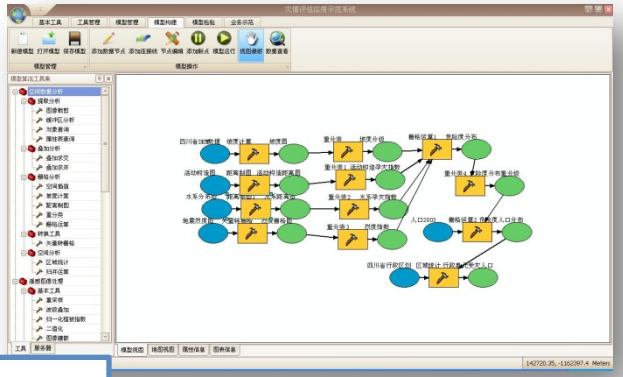
- **Data source assurance system**
  - *Satellite imagery :* High Resolution Satellite series, Resource Satellite series, Environmental Satellite series …
  - *Partnership*

    Line ministries : ministry of land resource, National Bureau of Mapping and Geo-information, National Geo-information Center…

    Business firms : Oriental Roadnear, PeaceMap, China Science Geo-do…
- **Geo-spatial base data framework construction**
  - *Completely covered satellite imagery* : Multi-phase medium and high resolution satellite imagery, completely covered the major provinces of grain production.
  - *Level by level base geography data* : Based on 2nd land use census data, build up provincial, county-level, village-level, and plot-level base geography dataset.
  - *Other data types* : Geo-referenced statistics, meteorology data, phenology data, hydrology data…

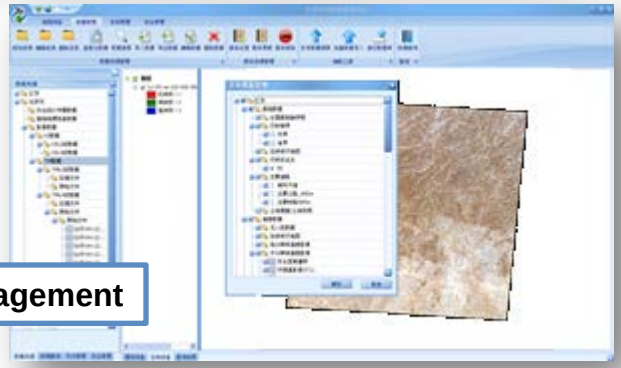
Statistical remote sensing data sharing and service system

It will realize the transformation of agricultural statistics to plane or three-dimensional distribution form at spatial and regional level, which will improve the display methods and means of agricultural statistics , promote the standardization of statistical information, and enhance the ability of analysis, exploration and forecasting to agricultural statistics.

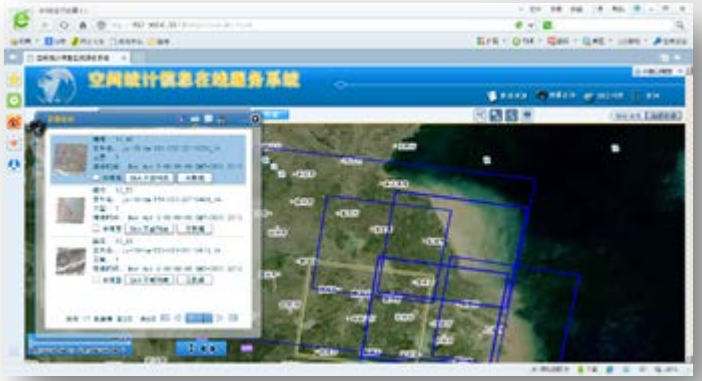


Process

Collection



Management



Distribution

Crop production survey vehicle

产品组成

野外调查车是由天合数维科技有限公司联合北京师范大学共同研制的新一代调查车，针对遥感监测工作的实际需求，基于运载车辆、通过航空、计算机、通讯、导航及 3S 技术的集成应用，形成机动灵活、集成度高、性能可靠、保障能力强的移动式车载调查系统，具备快速获取、快速处理和判读的能力，能够及时、准确的提供调查信息，为遥感监测工作的实际应用提供强有力的技术保障。

应用场景

Unmanned Aircraft (drones)

无人机可实现高分辨率影像的采集。弥补了卫星遥感和普通航空摄影经常因云层遮挡获取不到影像的缺陷，同时解决了传统卫星遥感重访周期过长、应急不及时等问题。

农业监测、地震、火灾、防汛、森林火灾监控、自然灾害区域评估等各方面的应急机构提供最及时、可靠、专业的高分辨率影像，为制定相应的应急预案、指挥决策提供最有力的数据支持。

优势特点

- **安全性高**：针对许多交通偏僻、危险或人员到达不到的地方，无人机可以降低不必要的人员风险，保障工作人员的生命安全，同时完成任务。
- **成本低廉、操作简易**：无人机虽然是一款高单价的产品，但它仍远低于采购卫星及有人飞机的设备成本，它在小面积航测中极具成本优势；无人机从起飞到降落全程全自动操作，整个飞行过程无需人为干预。
- **机动性高、自主灵活**：无人机体积小，便于携带，只要事先做好飞行准备，便可以自由起降。
- **搭载多样化**：针对不同的任务及需求，可以选择各种不同的数码相机及摄像机。
- **解析成果高**：无人机的飞行高度较低，可获取高分辨率的影像，影像的分辨率可达到 0.08m，甚至更高。
- **环境限制低**：无人机可以在大风、小雨、阴天等环境下执行任务，完全不受环境的影响。

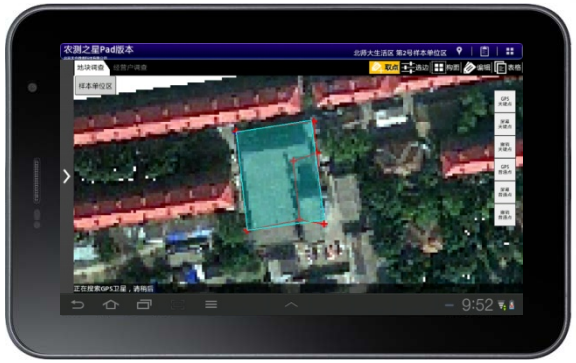
无人机组成

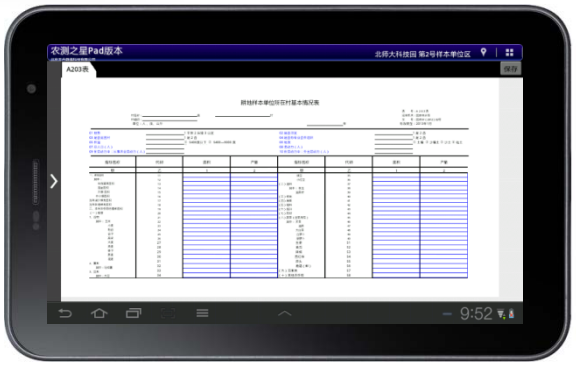
型号	飞机照片	载荷	作业时间	作业面积
Gatewing X100（测图鹰 X100）		理光 N5 1200 万像素	40min	3 平方公里（分辨率 15CM）
Swallow（飞燕）		Samsung NX200 2030 万像素	40min	4–5 平方公里（分辨率 8CM）
Avian（飞鹰）		Sony NEX–7 2430 万像素	50min	4–5 平方公里（分辨率 8CM）
T10（大黄蜂）		佳能 5D 2100 万像素	40min	4–5 平方公里（分辨率 5CM）

Mobile data collection devices

GPS (Windows Mobile)

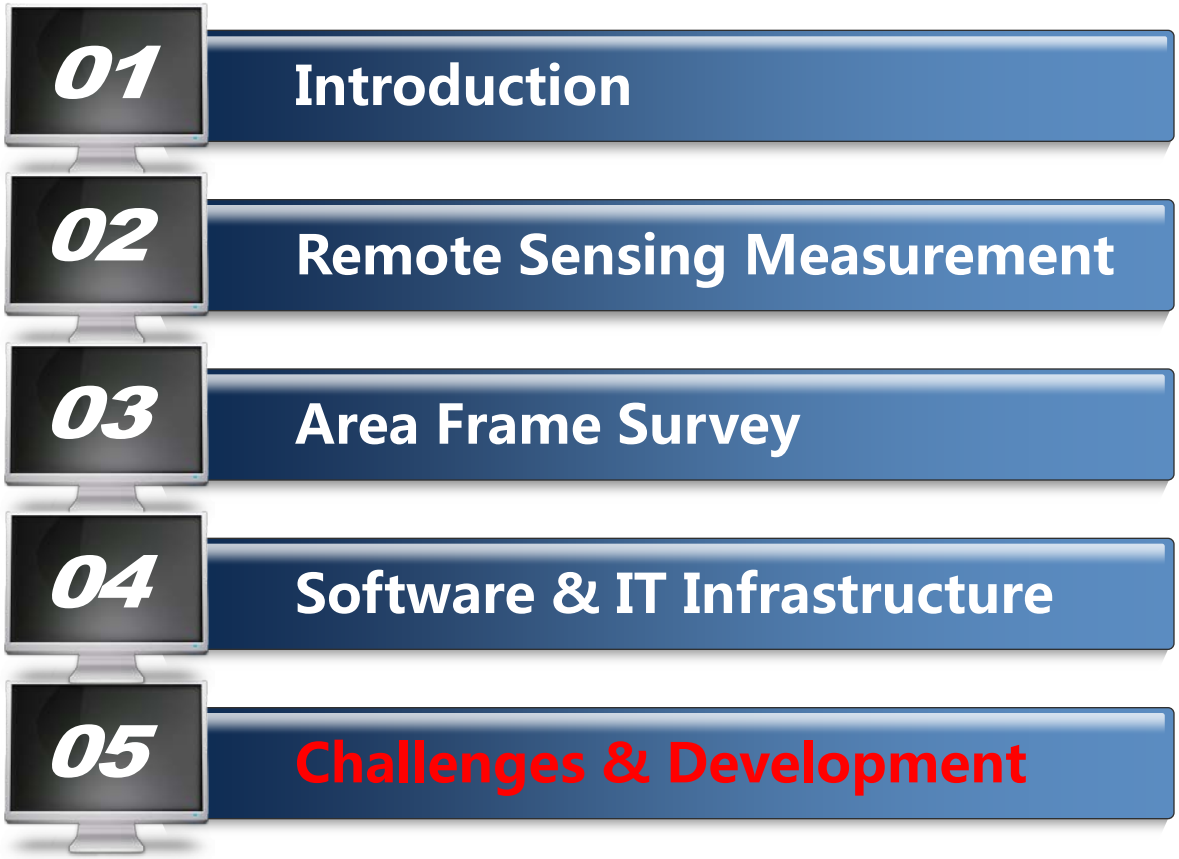
Smartphone (Explorer)





PAD (Android)

Outline


01
Introduction
02
Remote Sensing Measurement
03
Area Frame Survey
04
Software & IT Infrastructure
05
Challenges & Development

Challenges

- **Challenges from the complexity of farming in China**
  - **Complexity of farming structure in China :** Lots of crop types, region difference, Non-scale farming, multiple crop rotation, intercropping and interplanting.
  - **Fragmented landscape in most regions :** Except the northeast, the size of crop plots are very small.
  - **Complex terrain :** There are cropping in all kinds of landscape type, plain, hill, or mountainous area
  - **Largely impacted by market, the farming structure change rapidly**
  - **Following impact of the social and economical development, arable land changes very rapidly.**
- **Challenges from remote sensing technologies**
  - **Time phase requirement :** Because the crop planting is strongly seasonal, suitable satellite imagery must be acquired at specific period.
  - **Cloud and rain weather :** Because of the constraint of cloud/rain weather and satellite passing period, the data availability is very limited for large scale crop area remote sensing.
  - **Identification accuracy :** At complex situation, the accuracy of remote sensing identification must be researched to improve substantially.
- **Challenges from operational implementation**
  - **Cost** : It includes the infrastructure, purchase and process of imagery, geo-spatial framework, purchase of survey tools. If it were applied at national wide, bulks of fund are required.
  - **Worklord** : For the timeliness, huge volume satellite imagery must be processed in short time, and field work finished rapidly. The workload is huge. More manpower and resource are needed.

Future development

Improvement of technical ability, efficiency, data quality and services

Operational application

Evaluation → New system → Available Data

Survey means

Estimation

Spatial sampling | Small area estimation | Model estimation

Data basis

Remote sensing data | Base geographic data | Statistical data | Social and economic data | Climate data

Data source assurance system

Fully operational application

Integrated survey technologies to capture from space, air, fields

Self-contained methodology

Agricultural statistical OneMap


Thanks for your attention !