

# 水土保持碳汇途径与能力

## Approach and Capacity of Carbon Sink in Soil and Water Conservation

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### 1 水土保持碳汇主要途径

Main approaches of carbon sink in soil and water conservation

### 2 水土保持碳汇主要特征

Main characteristics of carbon sink in water and soil conservation

### 3 碳汇量计算方法与指标体系

Calculation method and index system of carbon sinks

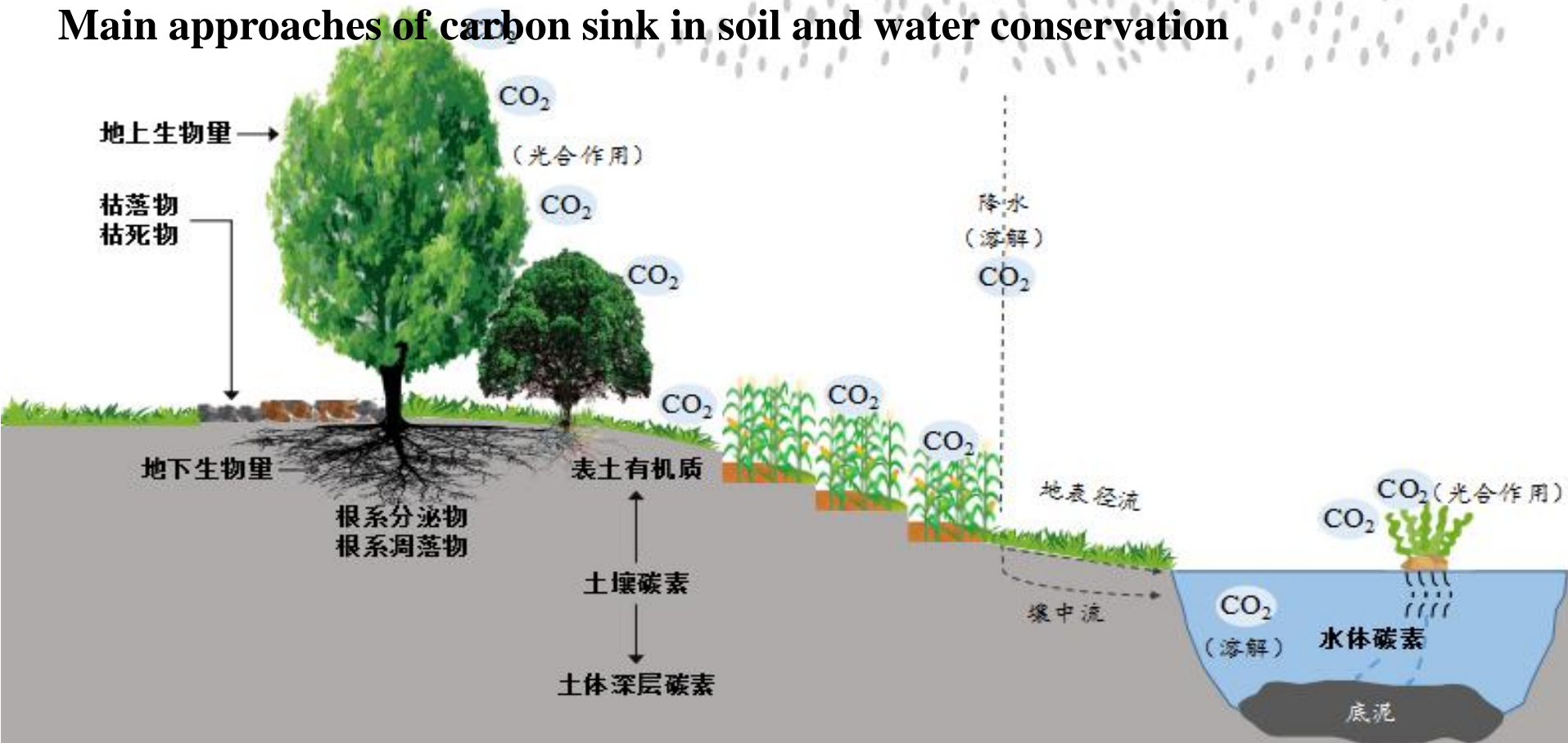
### 4 推行碳汇水土保持的主要做法

Main Practices for promoting carbon sink in soil and water conservation



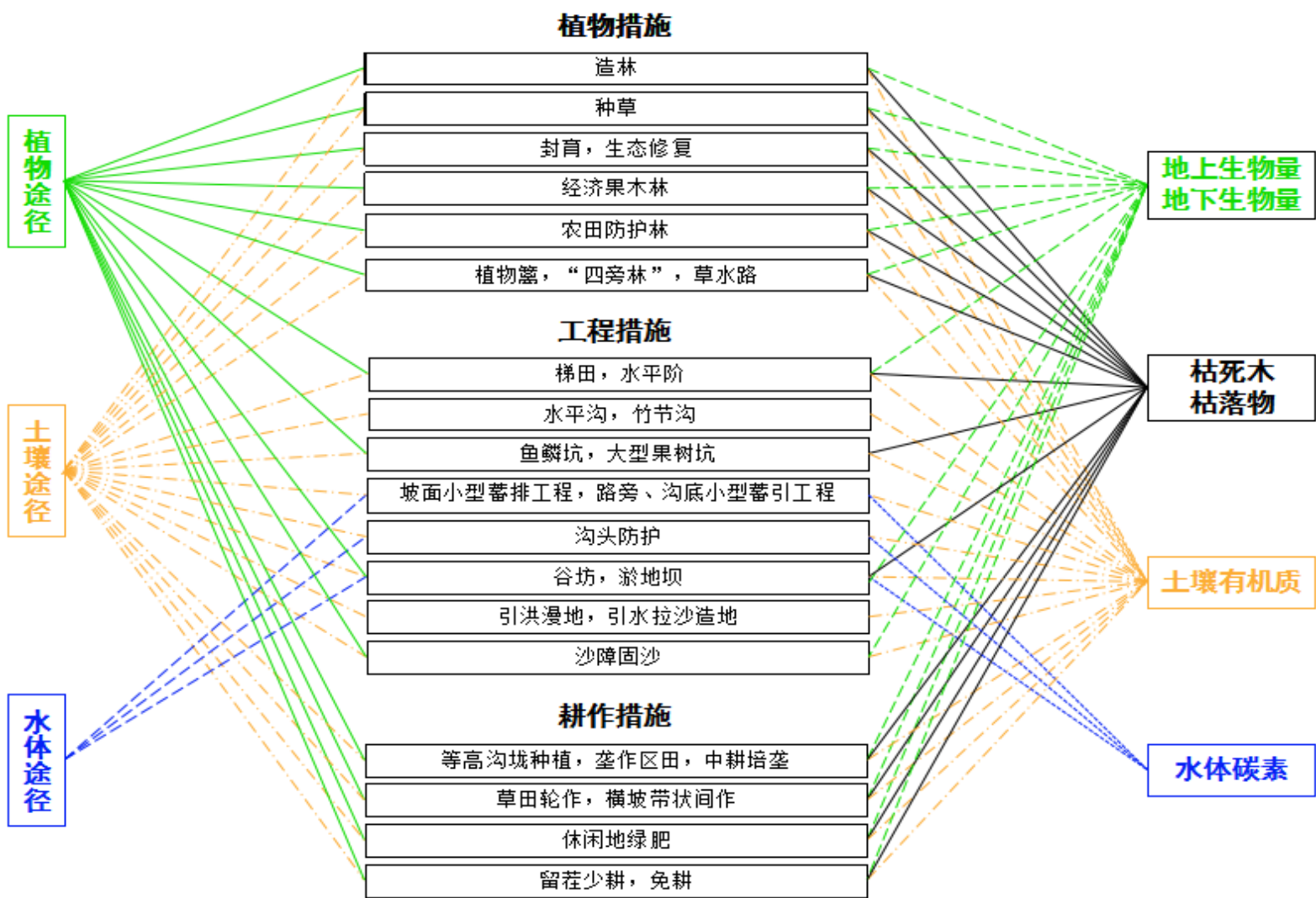
# 1 水土保持碳汇主要途径

Main approaches of carbon sink in soil and water conservation



# 碳汇途径和实物与治理措施的对应关系

## Corresponding relationship between carbon sink ways and objects and control measures







## (1) 淤地坝固碳减排增汇

Carbon fixation, emission reduction and  
sink increase in YUDIBA dams

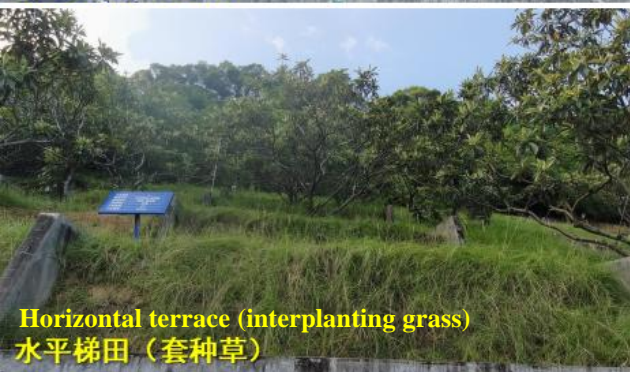


## (2) 梯田固碳减排增汇

Carbon fixation, emission reduction and sink increase in terraced fields



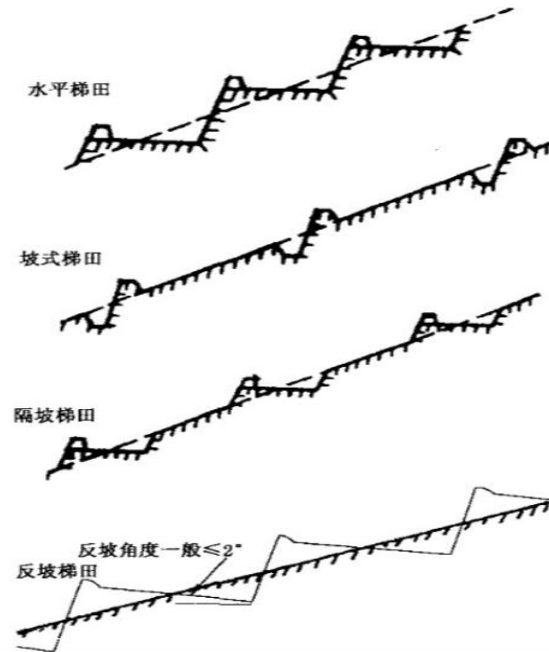
Horizontal terrace (net tillage)  
水平梯田（净耕）



Horizontal terrace (interplanting grass)  
水平梯田（套种草）



标准小区（顺坡抛荒）  
Standard community (abandoned along the slope)



梯田类型 Terrace type	因子值 $E$ Factor value $E$
土坎水平梯田 Horizontal terrace with soil ridge	0.084
石坎水平梯田 Horizontal terrace with stone ridge	0.121
反坡梯田 Adverse slope terrace	0.151
隔坡梯田 Slope-separated terrace	0.347
坡式梯田 Sloping terrace	0.414

### (3) 崩岗治理固碳减排增汇

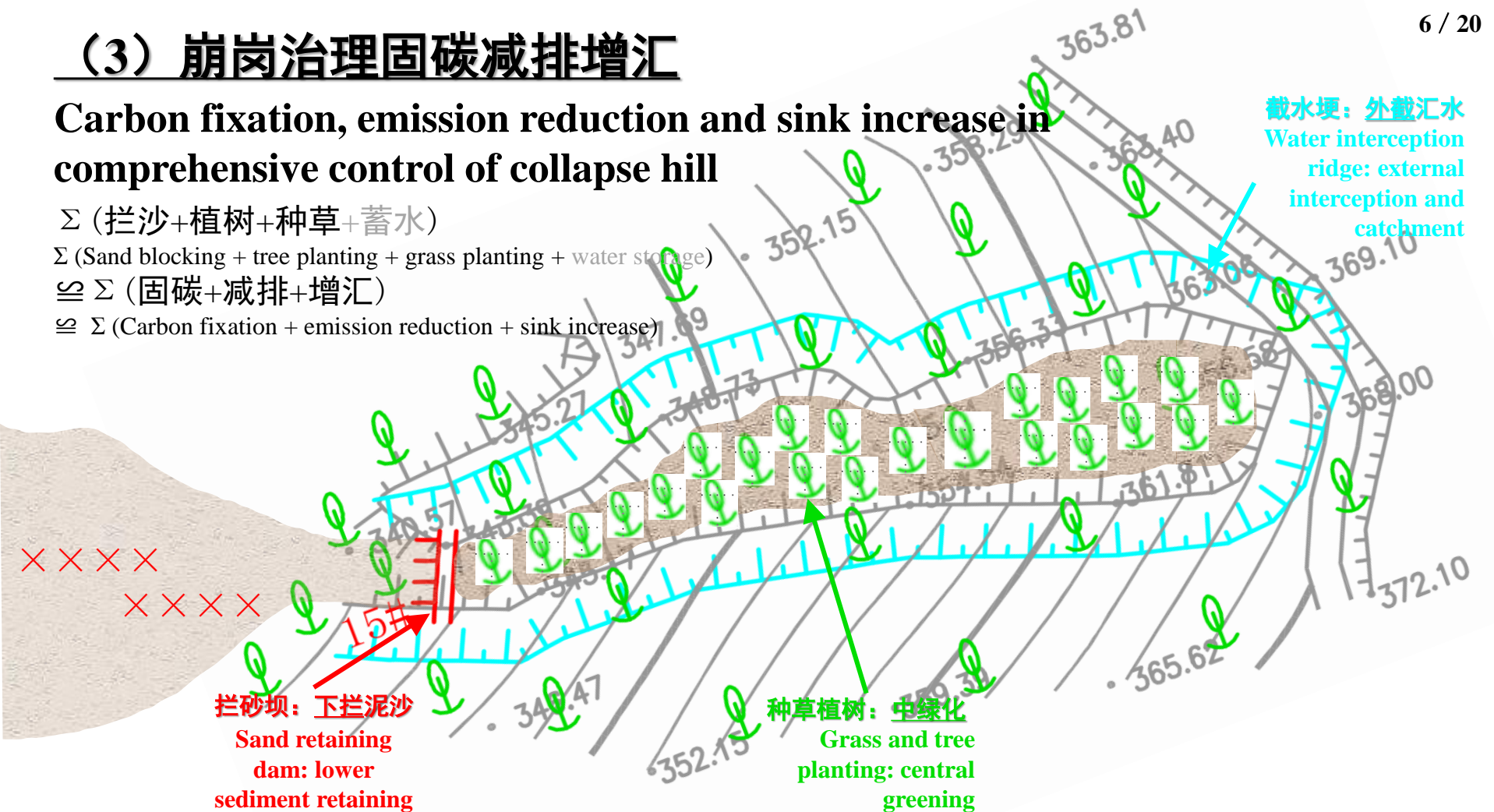
## Carbon fixation, emission reduction and sink increase in comprehensive control of collapse hill

$\Sigma$  (拦沙+植树+种草+蓄水)

$\Sigma$  (Sand blocking + tree planting + grass planting + water storage)

$\cong \Sigma$  (固碳+减排+增汇)

$\cong \Sigma$  (Carbon fixation + emission reduction + sink increase)

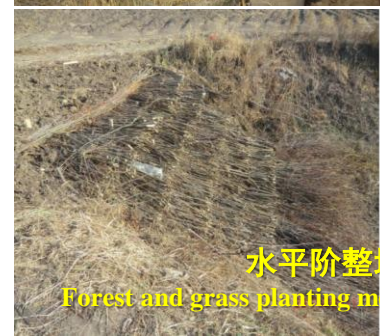
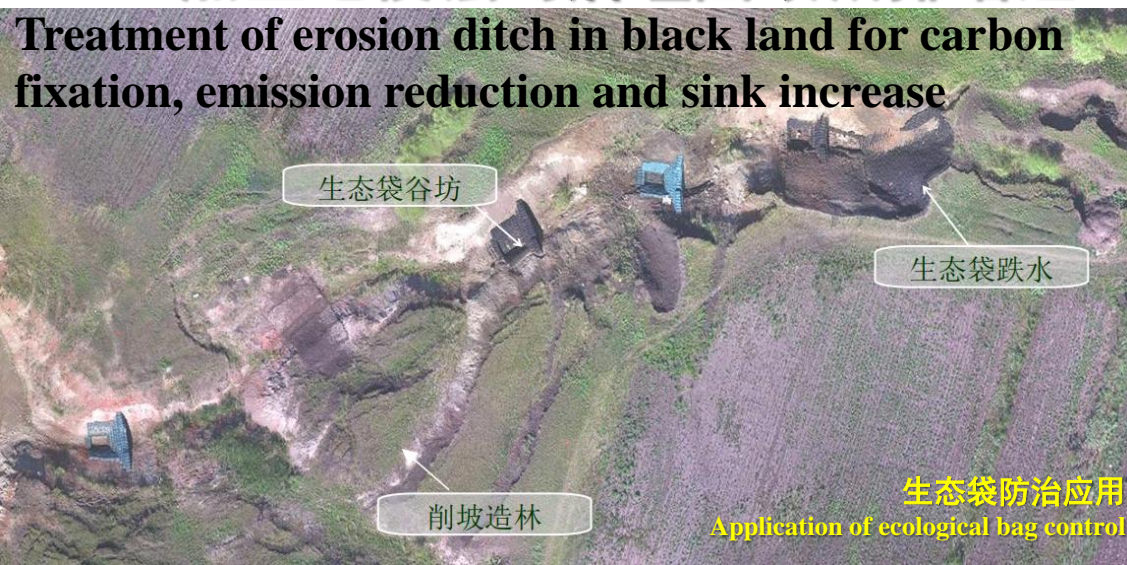






## (4) 黑土地侵蚀沟治理固碳减排增汇

Treatment of erosion ditch in black land for carbon fixation, emission reduction and sink increase



## 2 水土保持碳汇主要特征

### Main characteristics of carbon sink in water and soil conservation

水土保持碳汇，是指实施水土保持工程措施、植物措施和耕作措施后，所保育土壤、发育林草、培育作物、养育水体，通过吸收、同化和矿化等作用，不断削减大气中CO<sub>2</sub>含量、永续延缓CO<sub>2</sub>浓度的作用和能力。

Carbon sink in water and soil conservation refers to the role and ability of taking various measures such as water and soil conservation projects, planting and farming to conserve soil, develop forests and grass, cultivate crops, and cultivate water bodies, and to cooperate in multiple functions such as absorption, assimilation and mineralization, so as to continuously generate a variety of carbon sinks, continuously reduce CO<sub>2</sub> content in the atmosphere, and permanently delay the increase of CO<sub>2</sub> concentration.



# 水土保持碳汇特征<sup>5</sup>

## Characteristics of carbon sink in water and soil conservation<sup>5</sup>

<b>特征</b> <b>Characteristics</b>	<b>启示</b> <b>Inspiration</b>
<b>多种措施 共同作用</b> Multiple measures working together	<p>应根据各种措施的特点及其规格、品种和工艺，做好平面结构设计和立体空间配置，保障各类措施持续地、高效地发挥碳汇作用。</p> <p>According to the characteristics, specifications, varieties and processes of various measures, it's essential to make the plane structure design and three-dimensional space allocation well to ensure that various measures can play the role of carbon sink continuously and efficiently.</p>
<b>多种途径 相互交织</b> Multiple approaches interweaved	<p>为提高碳汇效能，应保证各种碳汇途径所发生的作用相互产生正效应，应设计好、实施好各种措施的数量、种类及其空间配置。</p> <p>In order to improve the efficiency of carbon fixation, we should ensure that various carbon fixation approaches have positive effects on each other, and design and implement the quantity, types and spatial allocation of various measures.</p>
<b>碳汇物质 的现地性</b> Locality of carbon sink materials	<p>措施实施好、实施多的区域，碳汇能力更强，具有更多的、不断增加的碳汇物质，具备更早实现碳中和的潜力。</p> <p>Areas with more measures implemented well have stronger carbon sink capacity and increasing carbon sink materials, and thus have the potential to achieve carbon neutrality earlier.</p>

# 水土保持碳汇特征<sup>5</sup>

## Characteristics of carbon sink in water and soil conservation<sup>5</sup>

<b>特征</b> Characteristics	<b>启示</b> Inspiration
<p>碳汇作用 存在极限 Limit of carbon fixation</p>	<p>水土保持率现值与阈值差距较大地区，应多实施、实施好措施，增大碳汇的措施基础；水土保持率现值与阈值差距较小地区，应提升措施质量和功能，提高物质累积，增强碳汇能力。</p> <p>In areas with large gap between present value and threshold value of soil and water conservation rate, more measures should be implemented well to increase the basis of measures for carbon sinks; in areas with small gap between present value and threshold value of soil and water conservation rate, it's essential to improve the quality and function of measures, raise the material accumulation, and enhance the carbon sink capacity.</p>
<p>多数途径短历时碳汇明显，全周期呈碳中性 Most approaches have obvious carbon sinks in short duration and are carbon neutral in the whole cycle</p>	<p>应不断优化、维护好和更新好措施，促进碳汇途径向着更根本的途径转换，增强水土流失防治功能，提高碳汇效能与生态服务成效。</p> <p>It's critical to optimize, maintain and update measures continuously, so as to promote the transformation of carbon sink path to a more fundamental path, enhance the prevention and control function of soil erosion, and improve the efficiency of carbon sink and ecological service.</p>



### 3 碳汇量计算方法与指标体系

#### Calculation method and index system of carbon sinks

$$Q_{TCO_2} = \frac{M_{CO_2}}{M_C} \cdot (FCS + GCS + WCS + CCS) + Q_{SCO_2}$$

$$= \frac{11}{3} (FCS + GCS + WCS + CCS) + Q_{SCO_2}$$

$Q_{TCO_2}$ : 水土保持碳汇总量 (CO<sub>2</sub>当量), t CO<sub>2</sub>·a<sup>-1</sup>;

$Q_{TCO_2}$ : Total carbon sink of soil and water conservation (CO<sub>2</sub> equivalent), t CO<sub>2</sub>·a<sup>-1</sup>;

$FCS$ ,  $GCS$ ,  $WCS$ ,  $CCS$ : 林地、草地、水体、农田固碳量, t C·a<sup>-1</sup>;

$FCS$ ,  $GCS$ ,  $WCS$ ,  $CCS$ : Carbon fixation of forest land, grassland, water body and farmland, t C·a<sup>-1</sup>;

$Q_{SCO_2}$ : 保土效益碳汇量, t CO<sub>2</sub>·a<sup>-1</sup>;

$Q_{SCO_2}$ : Carbon sink with soil conservation benefits, t CO<sub>2</sub>·a<sup>-1</sup>;

11/3: C转化为CO<sub>2</sub>的系数, 即44/12=11/3。

11/3: The coefficient of conversion of C to CO<sub>2</sub>, i.e., 44/12=11/3.

# 碳汇量计算方法特征

## Characteristics of calculation methods for carbon sinks

- ① 将措施类型及其配置体系、碳汇途径与碳汇量**紧密关联**  
Closely relate the type of measures and their allocation system, carbon sink path and carbon sink amount
- ② 将碳汇量估算与年度统计、定期普查的措施数据**紧密关联**  
Closely relate the estimation of carbon sinks to the measures data of annual statistics and regular census
- ③ 形成以**碳汇实物流**为基础的**技术路线**：措施及效益（碳汇物质）  
→ 碳汇途径 → 碳汇实物 → 碳汇量，为碳汇能力估算提供**基本方法**  
A technical route based on carbon sink material flow is formed: measures and benefits (carbon sink material) → carbon sink path → carbon sink material → carbon sink quantity, which provides a basic method for estimating carbon sink capacity



# 碳汇量核算统计指标体系

## Statistical index system of carbon sink accounting

1 水土保持 林地			面积 (hm <sup>2</sup> )	保土定额 (t hm <sup>-2</sup> )		
	1.1 乔木林地			<b>一级：4 类措施+保土效益</b> <b>Level 1: 4 types of measures + soil conservation benefits</b> <b>二级：9 种细分措施（面积）</b> <b>Level 2: 9 subdivision measures (area)</b> <b>参数：2+2+1 Parameters: 2 +2 +1</b>		
	1.2 灌木林地					
	1.3 经济果木林地					
	1.4 封禁治理林地					
2 水土保持 草地			面积 (hm <sup>2</sup> )			
	2.1 人工草地					
	2.2 封禁治理草地					
3 水土保持 基本农田	3.1 无固碳措施农田		面积 (hm <sup>2</sup> )	土壤厚度 (cm)	有机碳变化 (g kg <sup>-2</sup> a <sup>-1</sup> )	保土定额 (t hm <sup>-2</sup> )
	3.2 施用化肥农田		面积 (hm <sup>2</sup> )	单位面积氮肥施用量	单位面积复合肥施用量	保土定额
	3.3 秸秆还田农田	作物种类	面积 (hm <sup>2</sup> )	单产 (t hm <sup>-2</sup> )		保土定额
4 水土保持工程措施拦水水体			面积 (hm <sup>2</sup> )			

## 4 推行碳汇水土保持的主要做法

### Main Practices for promoting carbon sink in soil and water conservation

#### Σ (过程、活动或机制)

#### Σ (Process, activity or mechanism)

- 以增强碳汇作用、提升碳汇能力为目的  
To consolidate the role of carbon sinks and enhance the capacity of carbon sinks
- 科学实施碳汇水土保持措施  
Implement measures of carbon sinks in soil and water conservation
- 加强管护，避免措施损毁，保育措施良性发育  
Strengthen measures for management and protection to avoid damage and conserve healthy development
- 开展碳汇监测与核算  
Carry out carbon sink monitoring and measurement
- 积极推动水土保持项目参与碳排放权交易  
Participate in carbon emission trading by projects



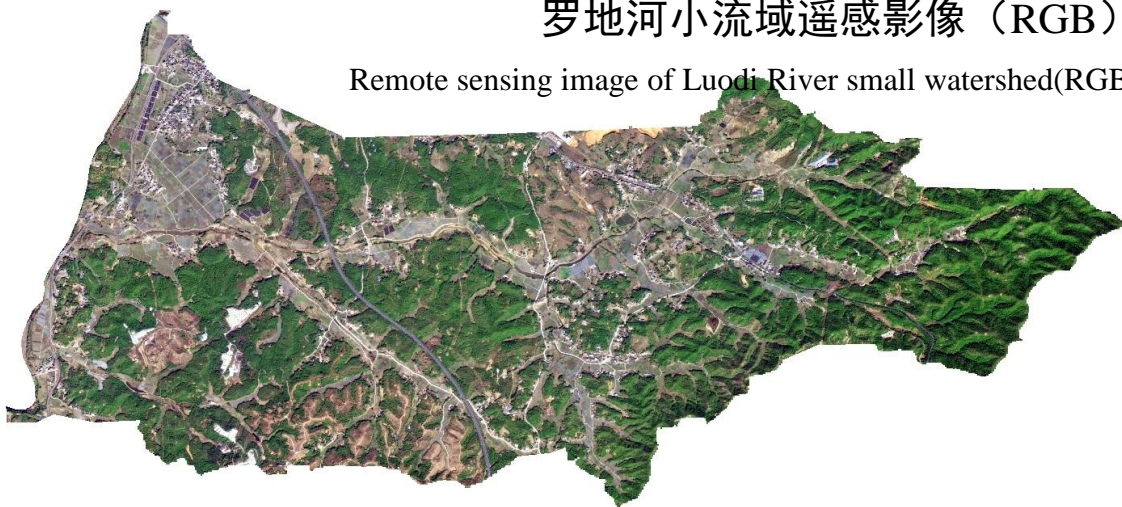
## 4.1 开展项目碳汇监测与核算

### Project carbon sink monitoring and accounting



罗地河小流域遥感影像（RGB）

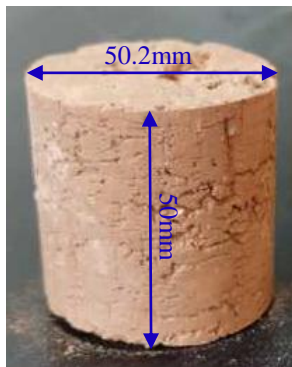
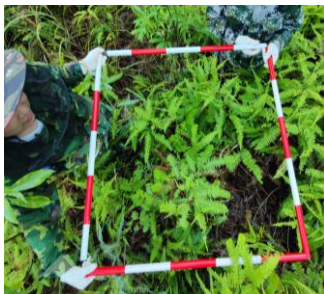
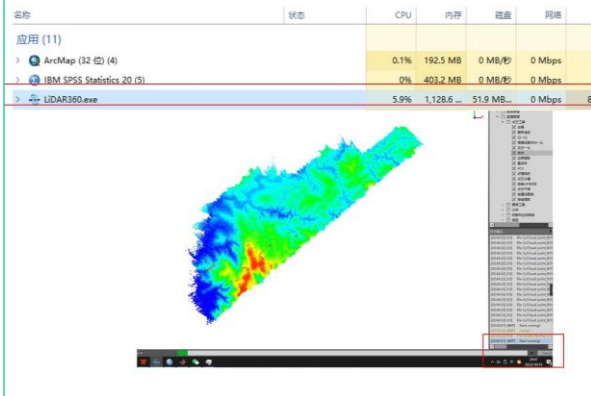
Remote sensing image of Luodi River small watershed(RGB)



# 样品采集处理 Sample collection and processing

机载Lidar处理步骤：数据合并-点云去噪-地面点分类-点云归一化-生成CHM  
需处理点云数据共991G

例：部分点云合并（76.5G）：处理速度慢，完全处理完约需3-4h

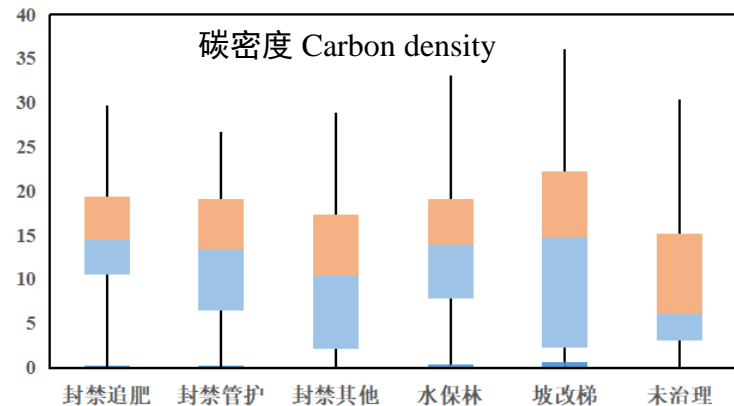


环刀土样



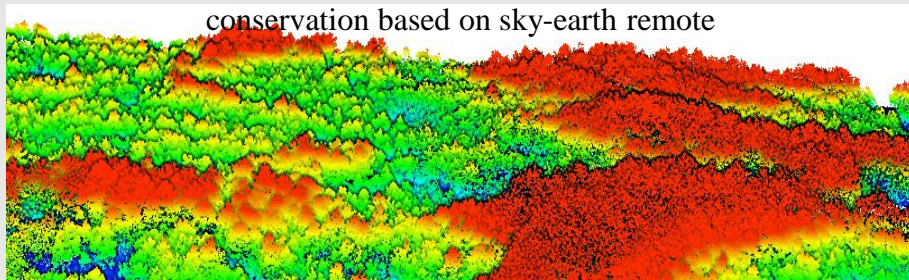


# 数据处理分析 Data processing analysis



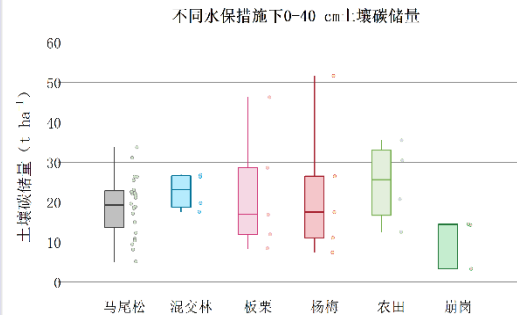
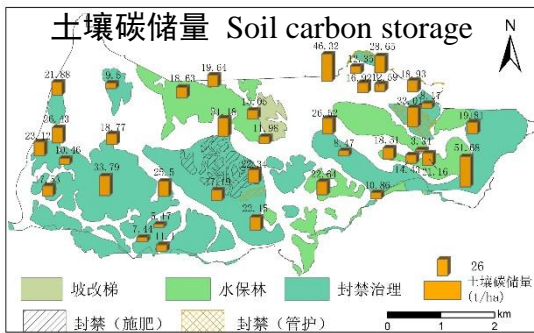
## 基于天空地遥感的水土保持林草措施生物量及碳汇时空分布估测

Estimation of temporal and spatial distribution of biomass and carbon sink in forest and grass measures for soil and water conservation based on sky-earth remote



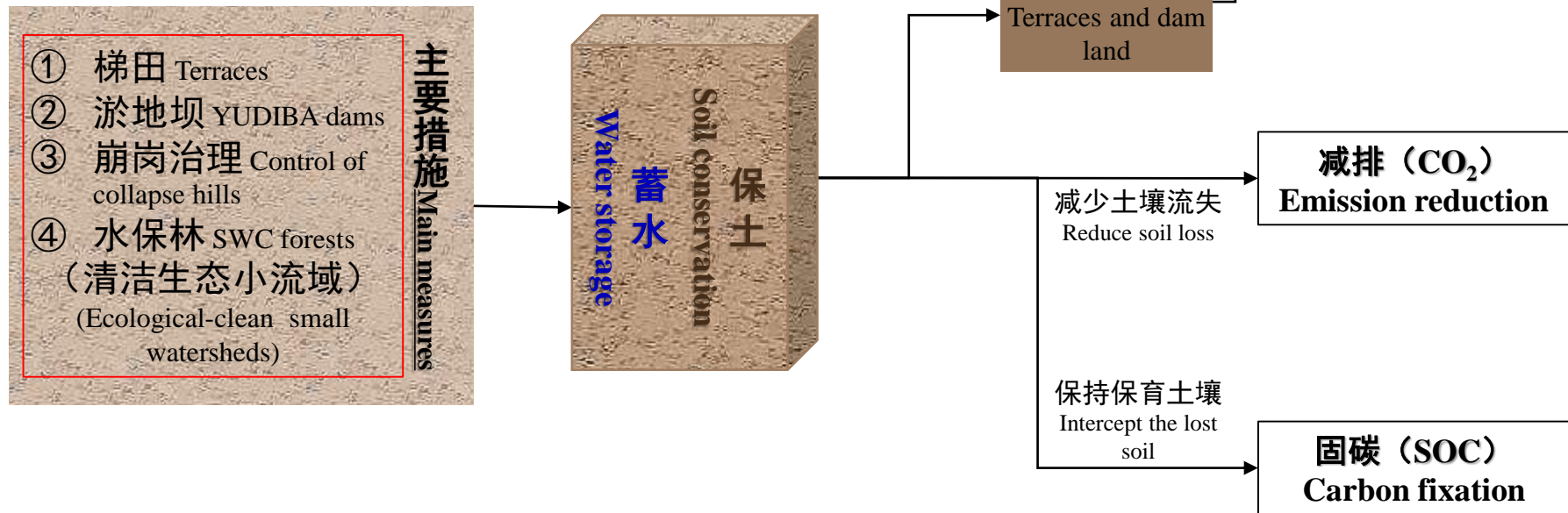
## 罗地河小流域不同水土保持措施土壤碳汇

Soil carbon sink of different soil and water conservation measures in Luodi River small watershed



## 4.2 研究主要措施固碳增汇机理

### Main measures of carbon fixation and carbon sink mechanism





### 4.3 实施碳汇水土保持措施

#### **Implement measures for carbon sink in soil and water conservation**

- ① 扩大林草措施和坡耕地整治比例，开展生态清洁小流域建设  
Expand forest and grass measures and the proportion of sloping farmland remediation, and carry out the construction of ecological-clean small watersheds
- ② 优化治理措施结构，增加长寿命、高碳汇林草比例  
Optimize the structure of control measures and increase the proportion of long-life and high-carbon sink forests and grasses
- ③ 完善措施管护制度，明确管护标准与要求  
Improve the management and protection system of measures and clarify the standards and requirements of management and protection
- ④ 加强人为水土流失监管，避免措施损毁和水土流失导致碳排放  
Strengthen the supervision of man-made soil erosion to avoid carbon emissions caused by damage of measures and soil erosion

## 敬请指正

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网址：	<a href="http://www.cnscm.org">www.cnscm.org</a> 中文域名：中国水土保持监测