Pasture Monitoring based on the Remote Sensing and Ground Observation Base (example of Balkhash area)

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Project K-1396p of ISTC
Partner USDA-ARS

Collaborators:

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Fig. 1 Research region
A modern pasture monitoring based on ground, space and air information.

First turn information processing based on:
- RASTURE algorithm (RK)
- RANGES algorithm (US)

Identification of model parameters (Bio pot.)

Modelling of production and conditions of plants based on PASTURE MODEL

- Landscape image
- Cover and biomass image
- Maps in M 1:200000, 1:2500000

- Current vegetation season biomass dinamic (t/ha)
- Firstly Production (t/ha)
- Season foods (t/ha of food units)
- Foods provided by agroclimatic resours (t/ha)
- Pasture area breeding optimal placing (units/ha)
- Pasture dinamic in under climatic change
- Carbon volume and CO₂ emission

- NOAA, Modis
- Landsat, IRI
- Air spectrometry survey
- Field observation incl. Spectrometry
- Geobotanical maps (retro)
- Meteo data
- Climate scenarios and atmosphere chemical conditions
First turn information processing algorithms

**PASTURE (RK)**

- NOAA / AVHRR Terra/Modis image (NDVI)
- Air spectrometry survey MSR 16 (NDVI)
  - 20 - 30 km
  - 500 m
  - 25 m

**RANGES (US)**

- Landsat, image bands 3,5,7 (SATVI and Neg 7 band)
- Field observation
  - 150 m
  - 90 m
  - 1 m

Cover and biomass ground and green
LANDSAT image of Balkhash area on July 25, 2006

Biomass image for “Southern” pasture polygon on July 25, 2006

Number of points: 7684
Minimum value: 278.000000
Maximum value: 894.000000
Mean value: 675.583160
Variance: 5833.526469
Standard deviation: 76.377526
Biomass image for “Southern” polygon on May 22, 2007

MODIS image of Balkhash area on May 22, 2007

Number of points: 126
Minimum value: 0.167471
Maximum value: 0.213540
Mean value: 0.180770
Variance: 0.000324
Standard deviation: 0.018008
Correlation between NDVI from MSR 16 radiometer and vegetation cover from field observation on polygon “Southern” in April - May 2007

Correlation between vegetation cover (%) and ground biomass (t/ha) from field observation on polygon “Southern”

1. – Ephemery – Artemisia of submontane plain in May 2007;
2. – Ephemery – Strubery of small-moutaine sands in May 2007;
3. - Grass- Strubery of height-mount's sands in May 2007;
4. – Haloxylon of takyr-plain in Ile river delta in August 2007;

• - 1x1 m area; △ - vegetation typ; x - 30x30 m area
PASTURE MODEL (RK)

This model simulates growth and destruction of nature pasture plants biomass.

\[
B_t = \frac{B_{pot}}{1 + \left\{ \frac{B_{pot}}{B_o - 1} \right\} \cdot \exp \int_0^t R_t dt}
\]

(1)

\[B_{pot} = P_h - P\]  

(2)

\[P_h = f(J, C)\]  

(3)

\[P = f(B_0)\]  

(4)

\[R_t = R_{pot} \cdot Ar\]  

(5)

\[Ar = f(J, T, W)\]  

(6)

where

- \(B_t\) – current annual biomass growth, t/ha;
- \(B_{pot}\) – potentially possible biomass, t/ha;
- \(R_t\) – plant growth function;
- \(Rm\) - \(R_t\) value under optimal agrometeorological conditions;
- \(J, T, W, C\) – environmental indexes (solar radiation, warmth, moisture, \(CO_2\));
- \(B_t'\) – biomass in destruction period, t/ha;
- \(Bt'\) – biomass destruction index;
- \(t\) – time from the beginning of vegetation period.
Fig. Modeling of ground biomass for pasture in 2007 agroclimatical condition on «Southern» polygon
Fig. Geobotanic map on “Southern” research polygon 1:200 000
Fig. Geobotanic map on Almaty region. 1:2 500 000
Fig. Corrected NDVI Ho on pasture land on “Southern” polygon in 2007-2008 spring and summer seasons from Modis image treatment. 1:2 500 000
Fig. Corrected Green biomass (T/ha) on pasture land on “Southern” polygon in 2007-2008 spring and summer seasons from Modis image treatment. 1:2500000
Fig. Results of treatment of Modis image for May 2008 for pasture lands for “Northern” research polygon. 1:2 500 000
## Ecological and Agricultural Index for Pasture Land Using on “Southern” Research Polygon in Change Agroclimatic Condition

<table>
<thead>
<tr>
<th>Farm, Site</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Bio</td>
<td>F.U</td>
<td>EV</td>
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<tr>
<td></td>
<td>T\ha</td>
<td>T\ha</td>
<td>T\ha</td>
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<tr>
<td>Site 1, c.24-35</td>
<td>2007 0.38</td>
<td>778 0.66</td>
<td>465 232</td>
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<tr>
<td>Small hilly sand</td>
<td>4300 head-2007</td>
<td>2000 head-2008</td>
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<td>Site 2, c.181</td>
<td>2007 0.26</td>
<td>232 0.21</td>
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<tr>
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<td>500 head -2007</td>
<td>750 head - 2008</td>
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<tr>
<td>Site 3, c.171</td>
<td>2007 0.23</td>
<td>165 0.14</td>
<td>100 50</td>
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<tr>
<td>High hilly sand</td>
<td>Winter pasture</td>
<td></td>
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<tr>
<td>Co. Camel C. 66</td>
<td>2007 0.42</td>
<td>367 0.33</td>
<td>220 110</td>
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<tr>
<td>18000 head -2007</td>
<td>2008 0.31</td>
<td>295 0.26</td>
<td>177 90</td>
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</tbody>
</table>
Fig. Agricultural index (food units/ha) for pasture use land on “Southern” research polygon by 70% probability and more 1:200 000
Fig. Ecological index (food, t/ha) for pasture use land on “Southern” research polygon by 70% probability and more 1:200 000
Fig. Ecological index (volume head-days/ha) for pasture use on “Southern” research polygon by 70% probability and more 1:200 000
The air temperature and precipitation dynamic in Kazakhstan area. (S. Dolgich. 2004)

1 – annual volume
2 – sliding 11-years period average
3 - trend line
## Agrometeorological condition for growth and accumulation of biomass on Pasture under influence of climate change in Southern Balkhash area

<table>
<thead>
<tr>
<th>Climate scenarios</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
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<td>0.3</td>
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<td>&gt;1</td>
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<tr>
<td>T°C, K, un</td>
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<tr>
<td>Bio, t/ha</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A2 2030</td>
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<tr>
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<tr>
<td>T°C, K, un</td>
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<td>0.30</td>
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</tbody>
</table>
Production of aboveground and underground mass by N.I. Bazilevich
Fig. Volume of primary production (aboveground and underground) on pasture land on “Southern” research polygon 1:200 000