AgriLIFE RESEARCH
Texas A&M System

A quick glance at SWAT modular codes

2015 SWAT Conference

Pula/Sardinia/Italy

18 June 2015

Jeong, J. & Her, Y.

Input Data Formats

- Object type based
  - Rather than subbasin & HRU based
  - No. input files remain the same regardless of No. subbasins & HRUs
    - Easy to handle input files
    - Efficient for large & fine-scale modeling & calibration
      - 137 Subbasins & 1212 HRUs (Brentwood watershed)
      - 40 files (modular) vs. 9400 files (rev. 629)
- Can we still use input files in the old formats?

Fig.1. Converter from old input file formats to the new ones (Developed by Dr. White)

From "ProjectName.dbf' to a set of input files in the new format

AgriLIFE RESEARCH
Texas A&M System

Input Data Formats

- How relationships between objects are defined?

Fig.1. Example of input data format ('subbasin.con')

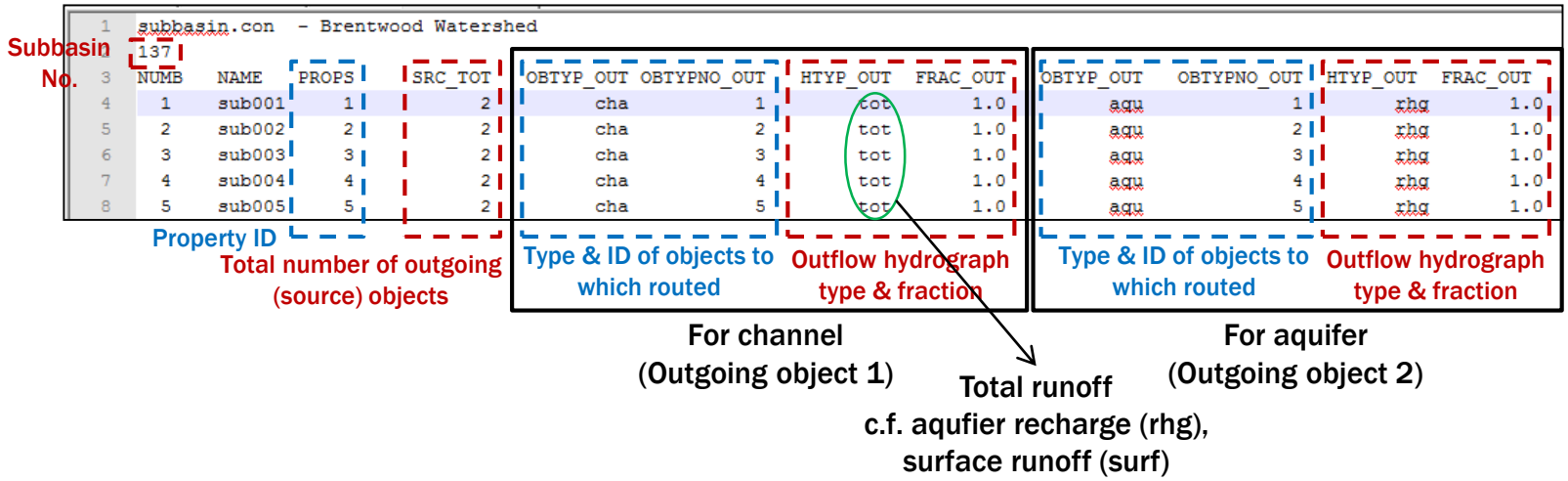
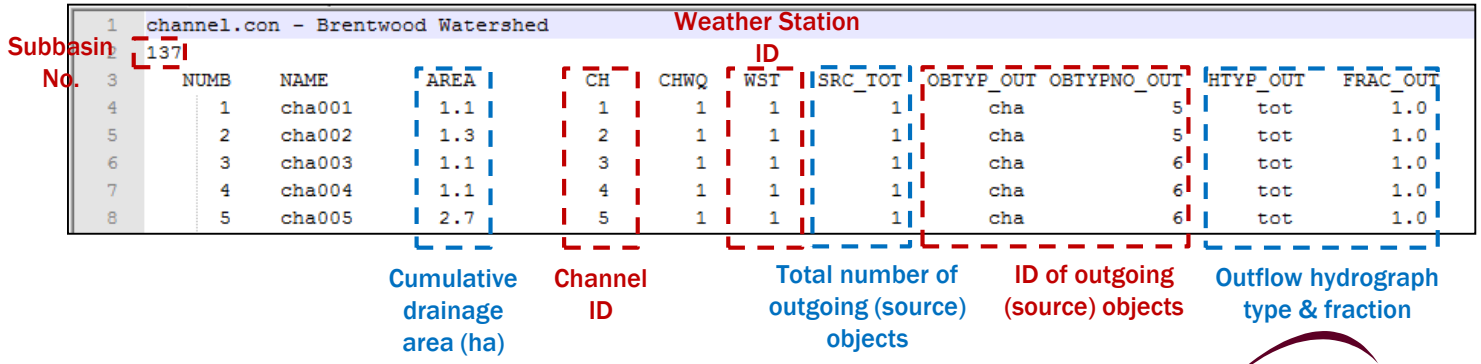


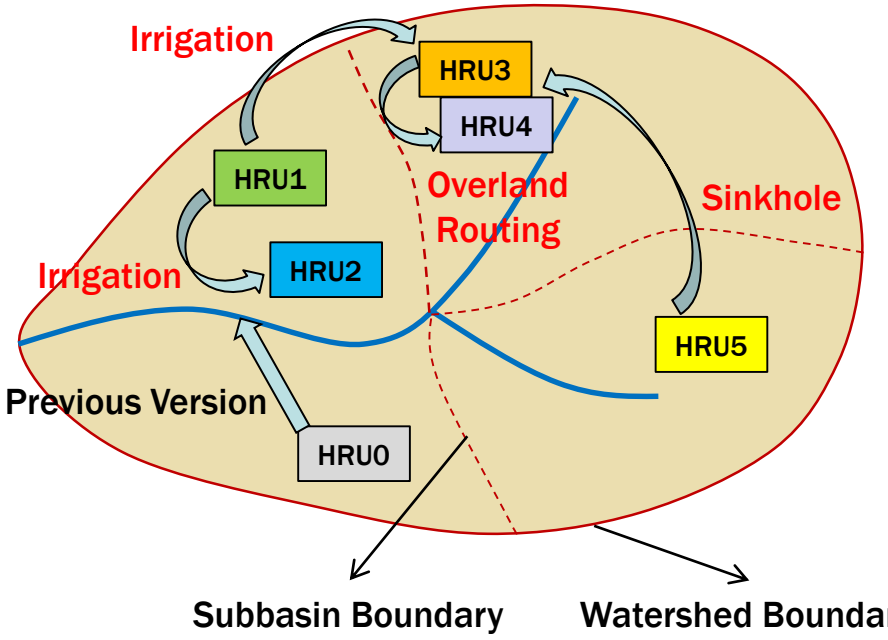
Fig.2. Example of input data format ('channel.con': similar function to that of 'fig.fig')



AgriLIFE RESEARCH
Texas A&M System

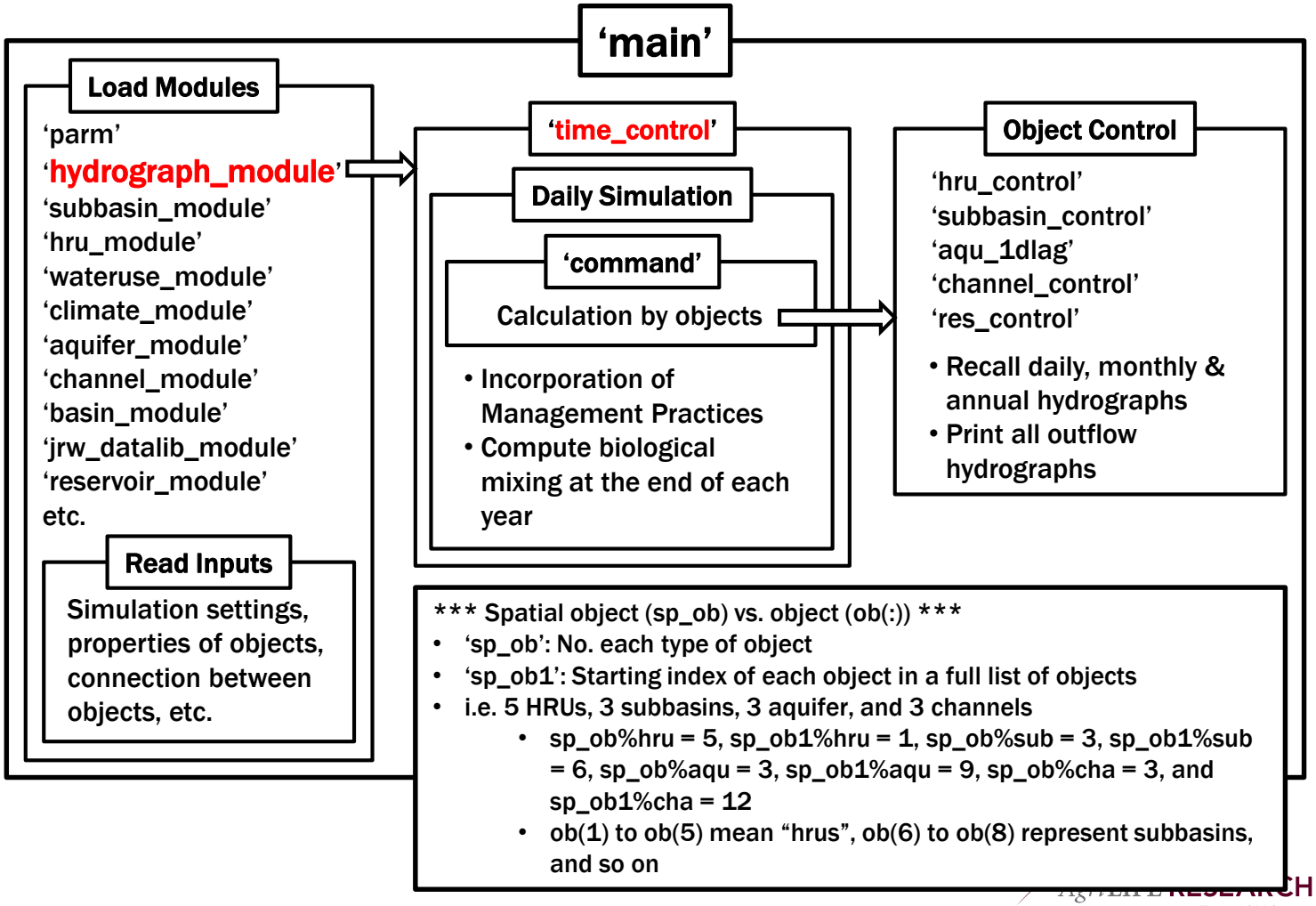
Model Structure

- Flexible modeling framework
  - HRU to HRU routing is possible
    - Direct runoff generated in a HRU can go any HRU
    - HRU-based overland (landscape) routing
  - Easily add objects & modify connections between objects
    - Point sources, irrigation, Karst, terraced paddy fields, etc.



Model Structure

- Overall structure



Model Structure

- Data Type?

```
type object_connectivity
  character(len=16) :: name = "hru_default"
  integer :: typ = 1       !object type - ie hru, hru_lte, sub, chan, res, recall
  integer :: props = 1     !properties number from data base (ie hru.dat, sub.dat)
  integer :: props2        !additional properties number from data base (ie chan wq)
  integer :: wst = 1       !weather station number
  real :: ha = 80.         !area - ha ! need to be changed to read areas from input files
  integer :: fired = 0     !0=not fired; 1=fired off as a command
  integer :: cmd_next = 0  !next command (object) number
  integer :: cmd_prev = 0  !previous command (object) number
  integer :: cmd_order = 0 !1=headwater,2=2nd order,etc
  integer :: src_tot = 0   !total number of outgoing (source) objects
  integer :: rcv_tot = 0   !total number of incoming (receiving) hydrographs
  integer :: rcvob_tot = 0 !total number of incoming (receiving) objects
  integer :: dfn_tot = 0   !total number of defining objects (ie hru's within a subbasin)
  integer :: subs_tot      !number of subbasins that contain this object
  integer :: elem          !subbasins element number for this object
  integer :: flood_ch_ob   !channel tha landscape unit is linked to
  character (len=3), dimension(:), allocatable :: obtyp_out    !outflow object type (ie 1=hru, 2=sd_hru, 3=sub, 4=chan, etc)
  integer, dimension(:), allocatable :: obtypno_out  !outflow object type name
  integer, dimension(:), allocatable :: obj_out      !outflow object
  character (len=3), dimension(:), allocatable :: htyp_out     !outflow hyd type (ie 1=tot, 2= recharge, 3=surf, etc)
  integer, dimension(:), allocatable :: ihtyp_out     !outflow hyd type (ie 1=tot, 2= recharge, 3=surf, etc)
  real, dimension(:), allocatable :: frac_out        !fraction of hydrograph
  integer, dimension(:), allocatable :: obtyp_in     !inflow object type (ie 1=hru, 2=sd_hru, 3=sub, 4=chan, etc)
  integer, dimension(:), allocatable :: obtypno_in   !outflow object type number
  integer, dimension(:), allocatable :: obj_in
  integer, dimension(:), allocatable :: htyp_in
  real, dimension(:), allocatable :: frac_in
  type (hyd_output) :: hin                           !inflow hydrograph for surface runon - sum of all inflow hyds
  type (hyd_output) :: hin_s                         !inflow hydrograph for lateral soil flow - sum of all lateral inflow hyds
  type (hyd_output), dimension(:),allocatable :: hd  !generated hydrograph (ie 1=tot, 2= recharge, 3=surf, etc)
  real, dimension(:), allocatable :: ts
  real :: peakrate                                   !peak flow rate during time step - m3/s

  type (hyd_output), dimension(:),allocatable :: hin_m
  type (hyd_output), dimension(:),allocatable :: hin_y
  type (hyd_output), dimension(:),allocatable :: hin_a
  type (hyd_output), dimension(:),allocatable :: hout_m
  type (hyd_output), dimension(:),allocatable :: hout_y
  type (hyd_output), dimension(:),allocatable :: hout_a
  type (hyd_output) :: hdep_m
  type (hyd_output) :: hdep_y
  type (hyd_output) :: hdep_a
  integer, dimension(:), allocatable :: obj_subs      !subbasins object number that contain this object
end type object_connectivity
type (object_connectivity), dimension(:),allocatable, save :: ob
```

ob(i)%subs_tot

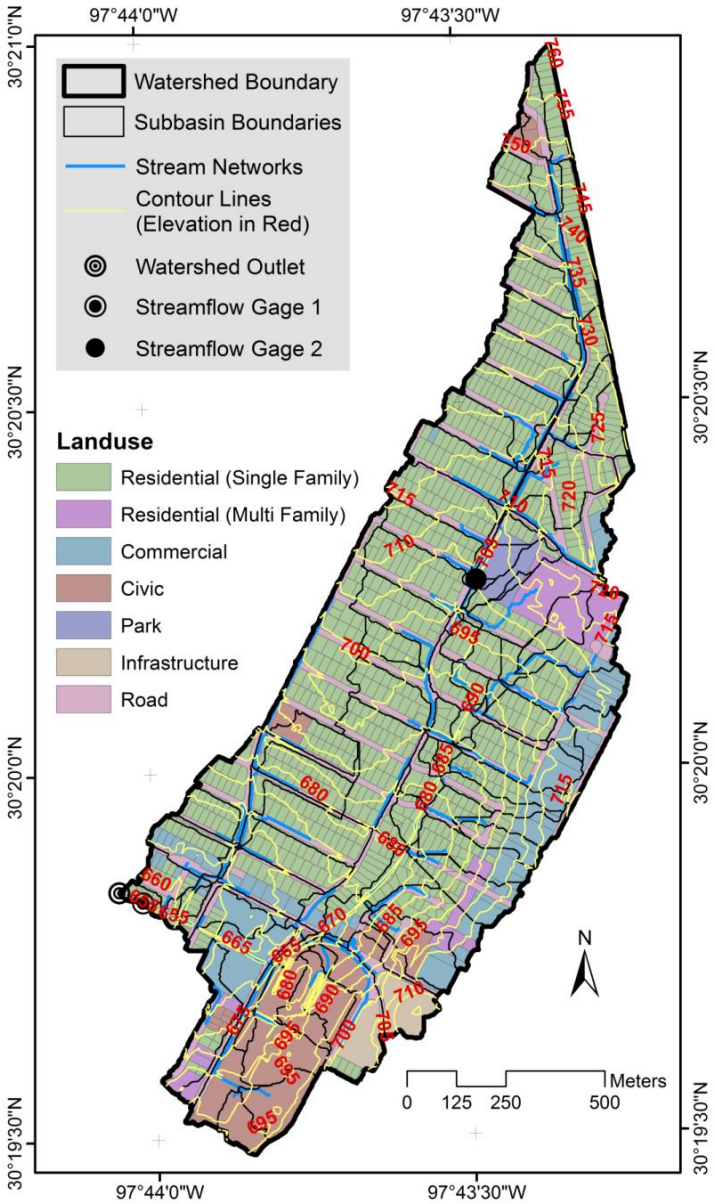
- 'I': object index
- 'subs_tot': a property of ob(i)

Challenges

- Runtime Initialization
  - Over 30 seconds with 137 subbasins & 1212 HRUs
  - Parallel loading?
- Routing scheme between spatial objects
  - Hard to track variables of each object
  - User Manual needed for developers
- Parallelization
  - HRU and subbasin-level computations are independent
  - Channel routing is inherently hierarchical process
    - But there are some options (P-SWAT, Wu et al., 2012)
    - Wu, Y., Li, T., L., S., & Chen, J. (2013). Parallelization of a hydrological model using the message passing interface. Environ. Modelling Software, 43, 124-132. http://dx.doi.org/10.1016/j.envsoft.2013.02.002.

SWAT for Brentwood Watershed

- Brentwood WS
  - Austin, TX
  - 149.8 ha
  - Highly urbanized
  - Monitored by City of Austin
- SWAT
  - Prepared by City of Austin
  - Great details
    - 137 subbasins (1.1 ha/sub)
    - 1212 HRUs (0.12 ha/HRU)
  - Calibrated by BRC



SWAT for Brentwood Watershed

- Calibrated SWAT
  - 'Good' performance; overestimated runoff volume

Fig. 1. Comparison of observed & simulated daily runoff

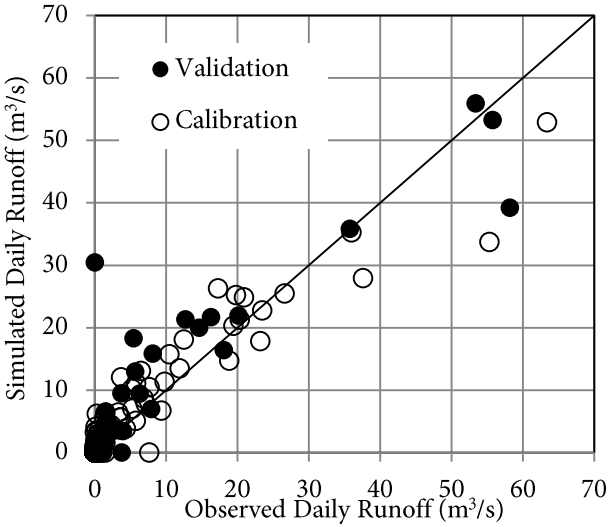


Fig. 2. Comparison of observed & simulated monthly runoff hydrographs

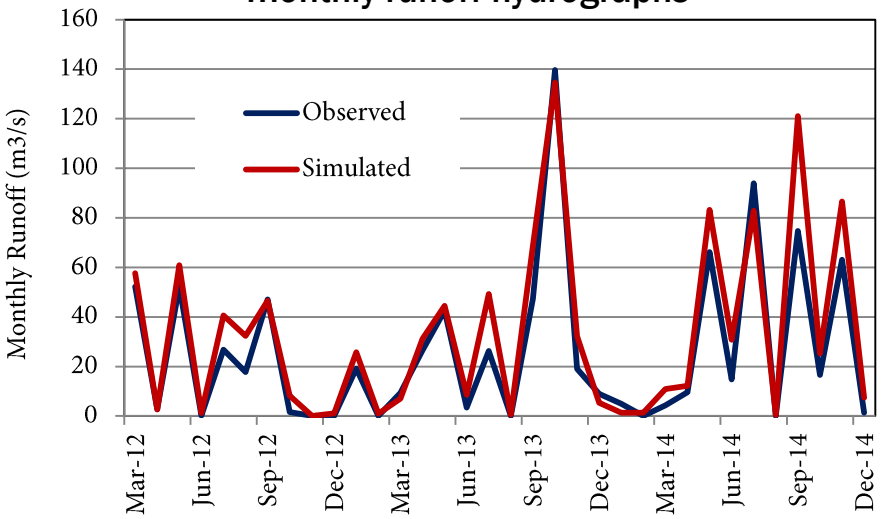


Table. 1. Performance statistics of the calibrated SWAT model

Period	NSE			R^2		
	15-min	Daily	Monthly	15-min	Daily	Monthly
Calibration	0.88	0.91	0.91	0.89	0.91	0.94
Validation	0.71	0.84	0.73	0.71	0.86	0.89

AgriLIFE RESEARCH
Texas A&M System